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Biological Survey of
Lisianski Island

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Lisianski Island

Tables, Figures and Plates

Table I
II
III

Dates and personnel
Population estimates and
breeding information
Species and status

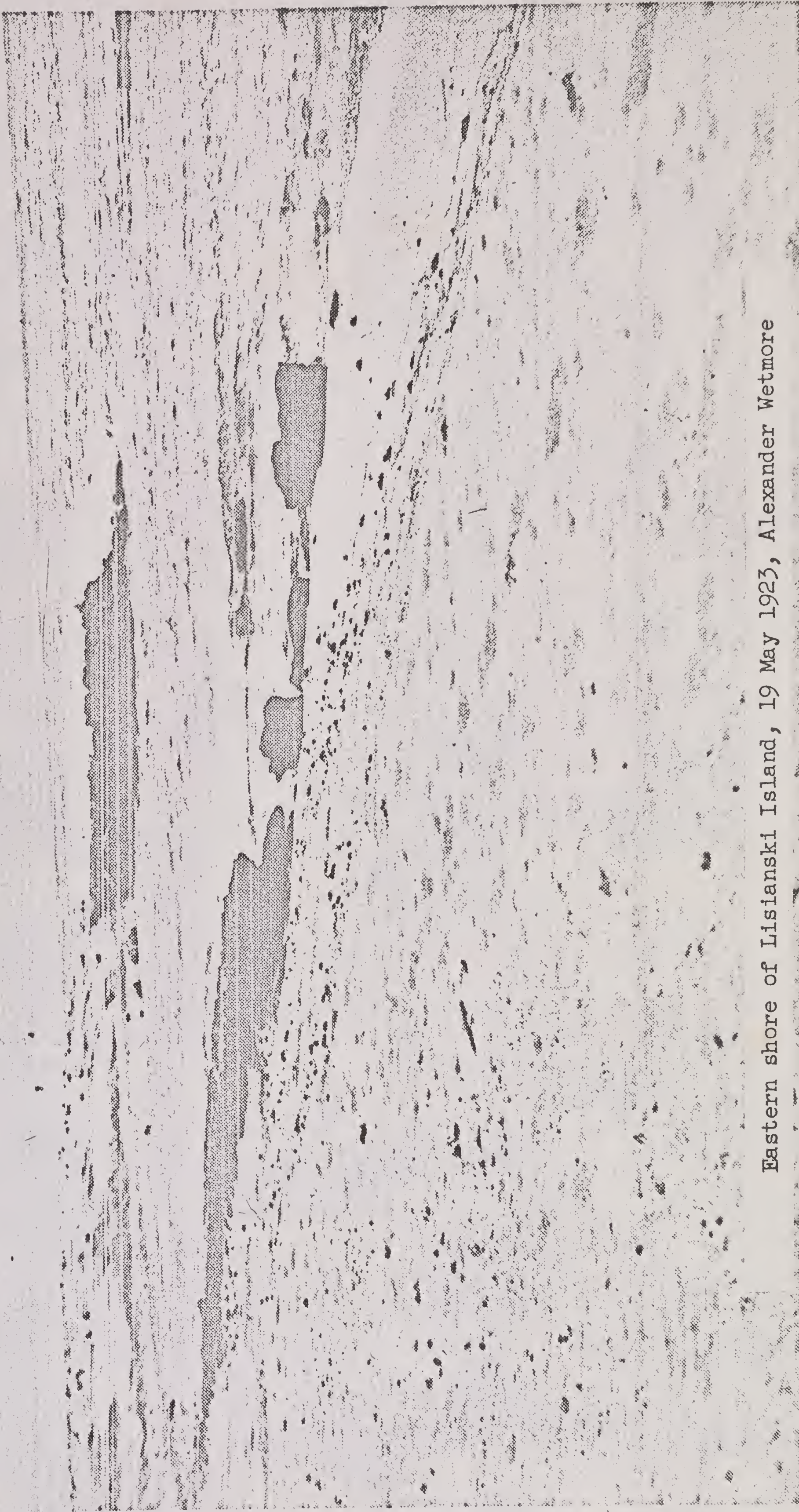
Figure I
II
III
IV
V
VI
VII

Lisianski Island 1805
Lisianski Island 1923
Lisianski Island 1942
Lisianski Island 1924
Temperature
Precipitation
Wind

Plate I
II

Lisianski Island, May 1923,
Alexander Wetmore
Lisianski Island, May 1923,
Alexander Wetmore

Eastern shore of Lisianski Island, 19 May 1923, Alexander Wetmore



Eastern shore of Lisianski Island, 19 May 1923, Alexander Wetmore

Introduction

Northwestern Hawaiian Islands

Lisianski is a low, sandy island in the Leeward Hawaiian Chain. It is located at $26^{\circ}01'$ north latitude and $173^{\circ}50'$ west longitude, approximately 1060 statute miles northwest of Honolulu and 225 statute miles southeast of Midway Atoll. The island is situated at the northern edge of a large reef bank which lies between $25^{\circ}56'$ and $26^{\circ}05'$ north latitude and between $173^{\circ}52'$ and $174^{\circ}01'$ west longitude. The reef covers an area of approximately 65 square miles, while the island has an area of 454 acres, or 0.7 square miles.

Other names which have ^{been applied} ~~been given~~ to the island include Pell ^{(Ward, 1967: Pell, 1844),} Lassion (Brooks, 1859), Sapion, Laskar, Lasan Rays and Neavas (Bryan, 1942, 180). The U. S. Geographic Board adopted the spelling Lisianski, rather than Lisiansky, in October 1924.

^{Thirty-three} ~~Sixteen sea bird~~ species are known to breed there, and ^{of birds are known to have occurred on the island.} ~~five migratory~~ ^{Fifteen are seabirds that regularly breed on the island} shore bird species have been regularly recorded. There are no terrestrial mammals or reptiles living there today, but ^{and five are regularly occurring} ~~sea turtles~~ are frequently seen ^{that are of regular occurrence.} ~~and there is a resident herd of Hawaiian monk seals.~~ ^{Green Turtles} ~~There are vague records indicate~~ ^{that} ~~of rodents on the island in the last century, and introduced rabbits seriously affected the ecology of the island in the early part of the present century.~~ ^{were} Marine life is abundant, but terrestrial invertebrate life is restricted to insects and a few arachnids. ^(incorrect almost certainly)

The island was discovered by the Russian explorer Urey Lisiansky in October 1805. It was visited by the Russian exploring vessel Moller in 1828, and vessels are known to have wrecked there in 1844 and 1846. ^{and} Exploring vessels visited the island in 1857 and 1859, and a ship went down on the reef to the south in 1887. A scientific collecting expedition visited Lisianski briefly

in 1891, and there are vague records of two additional visits in the latter part of the last century. The guano deposits of the island were briefly exploited in the early part of the present century, and the avifauna fell prey to ~~the depredations of~~ Japanese feather-poachers about the same time. Federal vessels visited the island nine times between 1904 and 1916 while patrolling the Federal Bird Reservation which was created in the Leewards in February 1909. Feather-poachers were arrested there in January 1910.

The Tanager Expedition spent five days on Lisianski in the summer of 1923, and personnel of the Bureau of Sport Fisheries and Wildlife and the Division of Fish and Game of the State of Hawaii made aerial surveys or visited briefly between 1956 and 1963. Several private and military scientific teams made brief visits to the island between 1950 and 1963.

In 1963 the Smithsonian Institution undertook an extensive program of biological research in the central Pacific, now known as the Pacific Ocean Biological Survey Program. Since February 1963 POBSP personnel have visited the island seven times. The initial results of our investigations are reported herein, with special emphasis on the vertebrate terrestrial fauna and the vascular flora. ^{and together with} Considerable effort has also been devoted to library research on the history of the island. Reports on other aspects of the program will be made at a later date.

6-7
let's see
if it
necessary?

History

The Russian exploring vessel Neva, Captain Urey Lisiansky, was the sister ship of the Nadejda, whose master, Captain Adam Johann von Krusenstern, commanded the first Russian circumglobal expedition. The ships sailed from Krönstadt in July 1803. They rounded Cape Horn in early March 1804 and turned

toward the Marquesas. The Neva turned north and visited Easter Island in April, rejoining the Nadejda at Nukuhiva in the Marquesas on 11 May. The vessels left Nukuhiva a week later and arrived at Hawaii in early June. The ships then parted; the Nadejda sailed for Japan while the Neva stopped at Kealakekua Bay, Hawaii, and Waimea Bay, Kauai, before sailing for Alaska, where she arrived at Kodiak on 8 July 1804. The Neva sailed from Sitka on 1 September 1805 with a cargo of furs, intending to rendezvous with the Nadejda at Macao. (Buck, 1953).

At ten o'clock ^{p.m.} on the night of 15 October 1805 the Neva grounded on an uncharted reef west of the Sandwich Islands (Lisiansky, 1814). ^{but} The crew was able to refloat the vessel by throwing cannon and other heavy objects overboard. At dawn the crew observed a low sandy island to the west. ^{the ship was driven} But then a sudden squall ^{by a sudden squall but was refloated} drove them on to another reef. They then discarded cables, anchors and all remaining heavy items, and by 17 October the ship was again ^{by 17 October as cables, anchors, and all remaining heavy items were discarded} floating. That evening some of the ship's officers landed on the island, and returned with four large seals that had been killed with hand spikes on the beach. ^{On the 18th} The following day the crew ^{retrieved} succeeding in retrieving the items they had ^{that been} thrown overboard to refloat the ship, and then went ashore on the island. They found numerous birds, which pecked at their legs and were kept away with difficulty. At almost every step they sunk almost to the knees ^{burrows} in holes dug in the sand by birds. [Creeping plants and grasses covered the sandy soil and obscured the bird burrows. Seals ^{and turtles} seven feet long were seen, and ^{but} turtles were abundant. They did not find water. A high pole was fixed in the sand, and a bottle containing an account of the island was buried near it. Shells, coral, sponges and other specimens were collected. They found a small ^{calabash} calabash with a round hole cut in it, and saw several high redwood

will
be
shortened

First Scientific Visit

The next known visit to the island was by another Russian exploring vessel, the Moller, Captain Stanikow. A party landed on the island on 22 March 1828 and the ship's surgeon, Herr. C. Isenbeck, "did his -" (Littitz in Rothschild, 1893:). Several years later, his observations were reported to F.H. van Littitz who subsequently wrote a paper that is translated in Rothschild (op. cit.) Isenbeck's observations comprise the first list of birds ^{these observations are} from the island but ~~are~~ in many instances of doubtful validity both as to species identification and as to observations on breeding biology.

logs, on the beach. "Amongst the birds we saw the most worthy of notice was a species of wild pigeon ... when flying at night it made a loud and disagreeable noise" [Probably the Bonin Island Petrel which frequently calls in flight at night.]

Lisiansky concludes his description of the island by stating that "this island promises nothing to the adventurous voyager but certain danger ... , to the southeast point of the bank where the vessel grounded, I gave the name of Neva; while the island itself, in compliance with the unanimous wishes of my ship's company, received the appellation of Lisiansky." A map of the island (Figure I) gives general outline and topography.

*Best evidence
overland*

Lisiansky did not rendezvous with the Nadejda at Macao, and reached Portsmouth on 28 June 1806. He received a great ovation from the Russians, and honors and presents were poured on him and his crew, when they anchored at Krönstadt on 4 August 1806, two weeks ahead of his commander (Buck, 1953).

The Russian exploring vessel Moller, Captain Stanikowitch, cruised the Leeward Hawaiians in March 1828 (Kittlitz, 1834), and possibly in 1827 as well (Bryan, op. cit.). The ship's surgeon, Herr. C. Isenbeck, "did his best to bear all he saw in mind, and to prepare and keep as many of the birds, which were mostly caught by hand, as the very unfavorable circumstances allowed him to do." (Kittlitz, op. cit.). The Moller visited Lisianski on 22 March 1828, where "they again found all the larger birds as on Laysan, and mostly breeding; but none were found that they had not seen on Laysan."

This visit is of special interest, not only because it is the first record of the birds of the island but also because Isenbeck describes a duck and a rail seen both on Laysan and Lisianski. The Laysan Teal and the Laysan Rail have never been recorded scientifically for Lisianski Island.

Figure I

Lisianski Island 1805

T Shipwrecks

Lisianski, like other Keewah Islands, has had its share of shipwrecks. The circumstances of a number of these wrecks are known in detail, but ~~no one knows how many ships may have gone on the reef never to be heard of again.~~

The first known ^{wreck of the} ~~wreck~~ ^{Holder Borden 1112 1811} was that of the whaleship Holder Borden of Fall River, Massachusetts. The ship, captained by James J. Pell (from whom Lisianski Island derived one of its earlier, alternative names), ran aground on a sand bank at 3 am. 12 April 1811, and ~~stayed there until swung around and a~~

shaly thereafter the ship swung around into a coral reef from which she could not be extricated. By morning there was four feet of water in the hold. The crew, observing a low sandy island some four or five miles away, abandoned the ship taking everything of value with them to the island.

~~Subsequently~~ ^{subsequent} The ~~36~~ crew members spent some five months on the island, living on ship's provisions and seals, turtles, and birds. During their stay the crew built a schooner of nearly 35 tons from the wreckage of the Holder Borden. By September 8th, they had completed a vessel "painted, sheathed, and copper-fastened throughout" which was named the "Hope".

On 14 September, she sailed for Honolulu with Captain Pell and ^{most} ~~27~~ of the crew arriving there on 8 October. Eleven men were left behind to look after the rest of the wreckage and its cargo of whale oil (Ward, 1967: 31-51)

Pell then purchased the American brig Delaware in Honolulu and set forth on 20 October to recover the men and supplies on Lisianski. She arrived there on 1 November and spent 112 days there loading oil and ^{other} salvage from the wreck. Before departing on 14 December, Pell planted about 80 coconuts on the southeast point of the island (Ward, op.cit.)

January 11, 1811 (1811)

* Not November 1811 as indicated by Bryan, 1972: 192

13
29

The ~~whale ship~~ Holder Borden, Captain Jobish Pell, of Fall River, Massachusetts, sailed from Honolulu on 5 April 1844 with 800 barrels of sperm oil and 700 barrels of blackfish oil. At three o'clock in the morning of 12 April she ran upon a sand bank west of the Sandwich Islands. Shortly afterward the stern swung around and struck upon a coral reef, from which the crew found it impossible to extricate her. There she ground on the rock until she bilged, and by morning there were four feet of water in the hold. At daybreak the crew observed that they were upon an extensive reef of bare rocks, four or five miles from a low sandy island. The ship was stripped of everything valuable; 1400 barrels of oil, spars, rigging, anchors, chains, provisions, and the crew's possessions being successfully landed on the islands. (The Polynesian, 12 October 1844).

Shipwreck

Captain Pell reported that the island was found to be at $26^{\circ}01'$ north latitude and $174^{\circ}55'$ west longitude, which is called Drake's Island on Turner's map of the world. It was entirely encircled by a reef, with a good entrance in one place leading to a safe anchorage about a half mile from the island, in three or more fathoms of water. The reef, which extended for about 20 miles southeast to south-southwest on the windward side, had breakers which were frequently mast-head high, but the leeward side was comparatively calm.

The island was about three miles in circumference and thirty feet at its greatest elevation. A swampy lagoon covered with grass, into which the highest tides occasionally flowed, was found in the interior. The only plants were beach grass and a few flowering shrubs. Provisions were ample, as seals, turtles, wild ducks, and other fowl were plentiful. The ducks

were readily tamed. The crew dug wells and obtained fresh water which was somewhat brackish. Potatoes, melons, and other fruits and vegetables were planted, and soon sprouted, but withered for lack of rain. Rain fell for only twelve hours during the five months the sailors were shipwrecked, and the temperature remained in the 90's. The sea fowl frequently dropped dead suddenly, apparently from the heat.

The crew built a schooner of 35 tons, which they named the Hope, from the wreckage of their vessel. They were forced to fabricate saws from hoop-iron, but had a carpenter and blacksmith, a forge and sufficient coal, and other necessary items for ship building. The schooner, painted, sheathed, and copper-fastened throughout, was launched on 10 September 1844. Captain Pell and 24 of the crew sailed for Hawaii on the 14th, leaving eleven men on the island to look after the property, valued at \$30,000. She arrived in Hawaii on 8 October 1844.

An article entitled "A Romance of the Sea" in the Boston Bee for 2 April, 1845 gives a slightly different account of the ship wreck, and comments further on the Holder Borden and the Hope, but these comments are not relevant to the history of Lisianski.

Captain Pell purchased the American brig Delaware in Honolulu, and sailed from there on 20 October 1844 to recover the men and supplies on Lisianski. On 29 October they discovered a shoal, named after the ship, at 25°50' north latitude and 174°26' west longitude, where they were able to anchor in 15 fathoms of water. (Boston Daily Journal, 11 July 1845). (Taken from The Friend, Honolulu, date?).

On 1 November the Delaware anchored off Lisianski. The following day she was moved inside the reef and Captain Pell commenced loading the oil which had been left from the wreck. Only 900 barrels were saved, as the

Wreck of the Konohasset

Two years later another whaleship, the ^{426 ton} Konohasset, of Sag Harbor Massachusetts, met a similar fate. This ship, captained by Theron X B. Worth, struck a reef ^{about 17 miles from} near Isimash, at 1 a.m. on 24 May 1846 - and all hands were forced to leave in the lifeboats when the increasing swells over the reef bilged the ship. The following morning they rebounded the ship, and sighted Isimash from aloft. They proceeded to the island where they found the remains of the Holdea Borden, and ~~and~~ a house and wells that had been constructed by the crew of that ship. (The Friend, 15 August 1846)

* Various newspaper accounts ~~have also~~ spelled the name Conohasset but we did not resolve which spelling is correct.

Other Visits to Lisianski Dug in the 19th Century

Visit of the Manuokawai

On 11 May 1857 Captain John Paty landed on the island from the Hawaiian Schooner Manuokawai. His purpose in visiting the island was to ascertain the nature and amount of the guano deposits. He reported that the surface was covered with coarse grass and that fresh water was obtained by digging a hole five feet deep in the center of the former lagoon. ~~Birds fish.~~ He also found ~~the~~ ~~coral~~ ~~timber~~ and a house and other artifacts left from the wreck of the Holder Borden and noted that birds, fish, seals, and turtles were plentiful though not so abundant as at Laysan. No trace of the coconuts planted by Pell were found (The Polynesian, 6 June 1857; Bryan, 1942: 191-192).

Visit of the Gambier

returned to Honolulu on 14 September 1846. (The Salem Observer, 16 January 1847).

Captain John Paty visited the Leewards on the schooner Manuokawai in the summer of 1857, annexing the islands to the Hawaiian Kingdom. He landed on Lisianski on 11 May and reported that "the surface was covered with coarse grass;" ^{Wreckage from the} Paty found some wreckage with the name Holder Borden ^{was found} carved on it, ^{and} and the crew obtained fresh water ^{was obtained} by digging a hole five feet deep in the center of the former lagoon. Birds, fish, seals and turtles were ^{abundant} plentiful. ^{but not so plentiful as at Laysan. (Bryan, 1942: 191)}

His account includes directions for approaching and anchoring at the island.

(The Polynesian, 6 June 1857).

Captain N. C. Brooks cruised the Leewards for several months in 1859 in the Hawaiian bark Gambia. ^{from the Hawaiian bark Gambia about 1859} He visited Lisianski in May of that year. He reports (Pacific Commercial Advertiser, 11 and 18 August 1859) that Lisianski, ^{and subsequently reported its position, and comments on underwaters the} Laysan and Pell islands are one in the same, and that the island is located ^{surrounded reef, and sailing directions for the island; He made observations} at 26° north latitude and 175°57' west longitude. It is three by two miles and surrounded by a reef on which the sea breaks heavily. A bank extends southward for several miles, on which there is 19 fathoms of water, shoaling to eight fathoms near the reef. The reef is close to the island on the north and the east, but bulges westward on the west side to form a lagoon two and one half miles wide. He gives sailing directions for approaching and anchoring at the island, mentioning rock outcroppings, currents, and tidal fluctuations.

^{on the island that scarcely differed from Paty's.}

Brooks found good water on the island, and saw birds, fish and turtle. At the south end of the island, near the center, he found the former lagoon to be overgrown with shrubs. The camp and well of the Holder Borden party was found, and on the east point on a hill about 40 feet high was a lookout pole and cask. A ship's house which had been used for sleeping was found at the

Wreck of the Aften

In 1887 still another ship was wrecked on the reefs around Lisianski. The bark Aften, carrying a cargo of coal from New South Wales to California, ran aground on 13 April, and could not be gotten off. Captain Gilmour and the crew abandoned the ship ^{on the 16th} and sailed for Honolulu in the ship's two 28 foot lifeboats.

After sailing about 120 miles to the east southeast they found they could make ^{no} ~~little~~ headway against the north-east trades, ^{then they} and decided to turn about and run before the wind to Guam. ^{the loss of} Eventually, ^{the} ~~the~~ first mate was ~~lost~~ ^{lost} overboard, the ^{eventually} ~~ships~~ lifeboats arrived at Guam, after covering some 3,000 miles in 29 days (Cresswell, 1939: 53)

- go to previous page -

Visit of the Ada

In 1882 Lisianski was twice visited by the crew of the Ada, a British schooner that was engaged in harvesting fish, sharks, turtles, and bêche-de-mer in the Hawaiian heewards. On her first visit to Lisianski on ^{24 Jan} ~~3 May~~ 13 turtles and 47 bêche-de-mer were collected, ~~and~~ on her second visit (3-5 May) 107 turtles ~~were~~ ^(were killed) and 307 bêche-de-mer were taken.

Visit of the Kaalokai and the Rothschild Expedition

southern end of the island. The head-board of the Holder Borden, with the name Konohasset carved on it, was there also. A large redwood trunk was found on the north beach. On the west beach was a notice, left by the

One observation of interest was the discovery of the

San Diego on 27 April 1859, taking possession of the island for parties in San Francisco.

west beach of a notice that had been left

by the San Diego, 27 April 1859, and which took possession of

The British schooner Ada sailed from Yokohama on 10 December 1881, bound first for the Bonin Islands and thence to the Leeward Hawaiians where her owners and masters hoped to obtain a cargo of fish, shark, turtle, and bêche-de-mer. She reached Kure Atoll on 30 December, Midway Atoll on 1 January 1882 and Pearl and Hermes Reef on 19 January. On 24 January she anchored off Lisianski, and her crew collected 13 turtles and 47 bêche-de-mer. The schooner then visited Laysan, and spent almost three months at French Frigate Shoals, before returning to Lisianski on 3 May. On this visit she remained for three days while the crew killed 107 turtles and collected 307 bêche-de-mer. The Ada stopped again at Midway on 10 May for provisions for the return trip to Japan. (Mansbridge in Hornell, ed., 1934)

The bark Afton, bound from New Castle, New South Wales, for San Diego, struck a reef near Lisianski on 13 April 1887. Captain Gilmour decided to abandon ship as she was being pounded up on the reef, and make for Honolulu. Two 28 foot lifeboats were outfitted for the trip, and on 16 April they headed for Honolulu. After sailing for about 120 miles they discovered that they were not making any headway against the tradewinds, and decided to turn and run before the wind for Guam. With the wind they made 170 miles per day, but nearly died of thirst for lack of rain. The first mate, Alex King, who was in charge of the second boat, became entangled in his coat, fell overboard,

to his
visit of ornithological interest

The second scient. visit to Nihoa occurred during the summer of 1891 when the island was visited briefly by the Rothschild Expedition. Henry Palmer and his assistant, George C. Munro, had been engaged by Walter Rothschild to collect birds on the Hawaiian ~~Islands~~ Leeward Islands. The schooner Kaalokai, Captain F.D. Walker, had been hired to transport them to the various islands. They landed on Nihoa on 29 June remaining there until the 3 of July. Sixteen species of birds, four of them shorebirds, were recorded and numerous specimens were obtained (cf. Table — for additional details and references.)

Nihoa, Hawaii, June 29 - July 3, 1891

and drowned, but the rest of the crew made the 3000 mile voyage to Umata Bay, Guam in 29 days. (Cresswell, 1939).

In the summer of 1891 Henry Palmer and George Munro landed on some of the Leewards while on a collecting trip for the Hon. Walter Rothschild of England. The schooner Kaalokai, Captain F. D. Walker, was engaged for this trip. They landed on Lisianski on 29 June and remained until 3 July. Walker (1909) reported that much of the island was covered with low scrub brush, and that the island was rimmed by a sandy beach 100 feet wide. He estimated that a thousand tons of good guano remained in the dry lagoon of the interior, and found bird life plentiful.

Palmer (Rothschild, 1893-1900) reported that the island was not as well vegetated as Laysan. He found a low scrub growing around what he believed must have formerly been a lake on the south side. Both albatrosses had large young, Blue-faced Boobies had young, and Red-footed Boobies and Great Frigate-birds had nests in the scrub around the former lake. He found only two Brown Booby nests. Sooty Terns were most numerous, and had small chicks. Hawaiian Noddy Terns and Gray-backed Terns were seen, but were not breeding. Petrels were noted, but the three species noted were not described in his notes. He saw a few Bristle-thighed Curlews, Golden Plovers, Wandering Tattlers and Ruddy Turnstones, but does not mention ducks or rails. A seal was collected, but the skin was lost.

John Cameron, ^{on the sloop Eben} ~~on the sloop Eben~~, visited Lisianski ~~once~~ ^{to} in the 1880's and ~~again~~ in the 1890's, to kill seals and turtles for meat and fish for sharks. He vividly described ~~the~~ "myriads of mice" ^{that} ~~which~~ over ^{ran} the island, but made little reference to other animal life. (Cameron, 1928.) Since Cameron's book was written many years after his trips to the leewards, and, since no other observer from about that period reported "mice," we suspect that his observations about ~~of~~ Lisianski were confused with some other leeward island, perhaps Kure Atoll.

This will have to be rechecked

Lisianski - 1900 - 1930

Use of Lisianski for Mining Guano

Elschner stated that "at some time or other guano or phosphates were shipped" but only that of the best quality. When he visited island (1913) there were two houses that lay in the former lagoon that were surrounded by small patches of tobacco which had been introduced by Schottman. Notes that rabbits were introduced.

Lisianski - 1931 - 1960

Lisianski - 1961 -

Lisianski

The island was leased by the Hawaiian Kingdom to the North Pacific Phosphate and Fertilizer Company for a period of 20 years from 29 March 1890 (Bryan, ^{1942: 192} ~~op. cit.~~). ^{Sometime thereafter a} A small wooden house was built at the southern end of the island, and Max Schlemmer, island manager for the guano company, planted tobacco and released rabbits there sometime between 1901 and 1903. Only the highest quality guano was ever shipped out (Elschner, 1915).

^{On 8 January} ~~Sometime~~ ^{Feather poachers on Lisianski} early in 1904 a party of over 75 Japanese feather poachers landed on Lisianski. Captain A. P. Niblack of the U.S.S. Iroquois reported their presence in April 1904 (Log of the U.S.S. Iroquois for 11 April 1904), and went ashore to warn them of their violation of customs and immigration laws.*

On 8 June 1904 the United States Revenue Cutter Thetis, Captain O. C. Hamlet, was dispatched from Honolulu to carry mail and supplies to Midway Atoll, and on the ~~return trip~~ ^{to arrest any poachers that might be found} she was instructed to stop at Lisianski and ~~Laysan islands,~~ ^{on the return trip} where Captain Hamlet was empowered to arrest any feather poachers who might be found. [(Letter from O. C. Hamlet, Captain, Revenue Cutter Service, to the Secretary of the Treasury of the United States of America, dated 23 June 1904).]

The Thetis anchored off the ~~west side~~ ^{side} of Lisianski early on 16 June. ¹⁹⁰⁴ ~~and~~ Captain Hamlet, the ship's surgeon, an interpreter, a petty officer, and a boat crew went ashore. As they were coming in they "saw a number of people coming across the south end of the island; they seemed undecided, moved towards the place we were heading for and then stopped at times." Once they had been told, through the interpreter, that they were all to leave the island they were "like happy children... which seemed to be genuine."

* (Log of the U.S.S. Iroquois for 11 April 1904)

Ward, R.G. ed. 1967. American Activities in the Central Pacific
1790-1870. Vol. 2. pp. i-xiii and 1-596

[Bampton thru Futuna]

Ward, R.G. ed. 1967. American Activities in the Central Pacific
1790-1870. Vol. 4 pp. i-xiii and 1-695

[Hadd's Is - Motu Iti]

Ducks in 1844 + 1805

Ward, R.G. ed. 1967 - as above Vol. 1 pp. 1-316
[Abalag to Baker]

Ward, R.G. ed. 1967 - as above Vol. 3 pp. i-xiii and 1-655
[Gafenut to Kwajalein]

all: The Greys Press, Ridgewood, N.J

The camp, on the east side of the island, consisted of four thatched roof shacks which were used for sleeping, cooking, storing food, and also bird skins. "Great quantities of dead birds were lying in all directions." The Japanese had been on short rations for quite some time, and had dried large quantities of tern meat against the day when their rice should run out. The 77 men and their baggage were soon transferred aboard the Thetis to be taken to Honolulu. The package of dried bird skins and wings were left there to be picked up by a later schooner. The Thetis left Lisianski the same day.

On the return trip Captain Hamlet questioned Tsunetare Sugiye, manager of the party, to determine the exact nature of the feather-poaching operations, and learned the following information. The Japanese party landed on Lisianski on 8 January 1904; no Japanese had visited the island prior to their landing. The party arrived at Midway in Yeiju Maru, but were told they could not stay there without permission from Honolulu, so they continued on to Lisianski. There 38 men went ashore and built a camp while 10 remained on the vessel. About 18 January the Yeiju Maru broke adrift in a heavy gale and was smashed on the reef, with the loss of her entire crew. In late February 39 additional men were put ashore from the Taiyo Maru. ^{which left} She left Lisianski for Tokyo on 1 March 1904 with no cargo. [Most of the materials for the buildings were brought from Japan. The manager had previously been on Wake, but no other American island. Most of the parties collecting feathers for Japanese firms went to Guam or South Pacific islands belonging to Japan.] ^{By the time} At the time the Japanese were removed from Lisianski they had collected 119 sacks of wings, 100 mats of whole, dried birds, and 116 cases of birds and wings. Most of the birds killed were Sooty Terns, which, according to the manager, were best killed from mid-July to mid-August when they were lean and easiest to preserve.

Albatross feathers, usually from the Laysan Albatross, were collected from September to January, so that the crews were able to work almost all year. They preferred to kill Fairy Terns, but did not find them sufficiently numerous. Black terns [perhaps noddies] were seldom killed. The large numbers of dead birds with feathers remaining, found by Captain Hamlet, had been killed solely for the breast muscles, which were dried for food. According to the manager, the party had killed 283,991 Sooty Terns on Lisianski, not counting those killed solely for food. ~~[The Japanese believed that the Sooty Terns moved from island to island, laying one egg and raising one young every four months, so that they believed that they were not harming the bird populations with their slaughter.]~~ *idiot work*

As there was no law protecting the birds in 1904 the Japanese were not prosecuted. The United States claimed the feathers, and dispatched a vessel to retrieve them. However, they were removed, probably by the crew of the Wiji Maru, before Captain Weisbarth of the Lavinia could make the return trip to Lisianski. The Wiji Maru later wrecked on Pearl and Hermes Reef and part of her crew was found on Lisianski in September 1904, along with part of the crew of the Tanzi Maru. (Bryan, op. cit.).

On 17 December 1904 Max Schlemmer, manager of the North Pacific Phosphate and Fertilizer Company's operations in the Leewards, submitted a letter to G. R. Carter, Governor of the Territory of Hawaii, requesting a 99 year lease on the islands of Laysan, Lisianski, and French Frigate Shoals. He stated that he would agree to plant 1000 coconut trees per year, that he would pay the Territory a royalty of 50 cents per ton on all guano removed, and that he would agree to protect the birds, providing that he would be allowed to kill so many per year for their skins. The Territory was to receive a 10

percent royalty from the sale of the skins. (letter from Max Schlemmer to G. R. Carter, dated 17 December 1904).

His letter includes a list of the numbers and species he wished to kill each season. The total, excluding Great Frigatebirds, all of which he intended to kill each season, was an unbelievable 21,800 birds. The list included 1000 Laysan Rails, 100 Laysan Honey-eaters, and 100 Laysan Miller-birds, three species which are now extinct.

Schlemmer's letter, plus newspaper accounts of the bird slaughter by Japanese feather poachers, came to the attention of William Dutcher, President of the National Association of Audubon Societies. Dutcher and William A. Bryan led the drive to stir up interest in creating a Federal refuge. Thus, President Theodore Roosevelt signed Executive Order 1019 in February 1909, placing all the islands from Nihoa to Kure, with the exception of Midway, under Federal protection.

In January 1910 the Thetis, under the command of Captain W. V. E. Jacobs, was sent to the Leewards to investigate reports of renewed Japanese feather poaching. An armed boarding party was sent ashore at Laysan on 16 January and arrested 15 Japanese found there. Large quantities of feathers, wings and stuffed birds were confiscated (Log of the Revenue Cutter Thetis for 16 January 1910). Captain Jacobs also confiscated several documents; an agent's commission from the Pacific Guano and Fertilizer Company to Max Schlemmer dated 6 May 1904, a police constable's commission for the county of Oahu and the western group of islands dated 13 May 1907, and a contract between Schlemmer and Geukichi Yamanochi of Tokyo for the rental of Laysan and Lisianski and a definition of the conditions under which the islands were rented. (ibid. for 17 January 1910).

On January 19 the boarding party sent ashore at Lisianski found and arrested eight more Japanese poachers, and confiscated additional plumage (ibid. for 19 and 20 January 1910).

The Thetis stopped at the other islands of the refuge on this trip, but found no other indications of poaching (ibid. for 21, 22, 23 and 29 January 1910). She returned to Honolulu on 2 February 1910, and the 15 Japanese poachers were turned over to U. S. Marshall Hendry (ibid. for 2 February 1910). The plumage from an estimated 200,000 albatrosses, valued at \$112,000 was turned over to customs agents (Paradise of the Pacific, 3 February 1910).

The Thetis visited Lisianski on 1 September 1910 (Log of the Revenue Cutter Thetis for 1 September 1910). The shore party found no signs of human habitation and reported that the notices regarding the bird reservation were still intact. On 28 April 1911 she again stopped at Lisianski, and the shore party reported no indications of the island being recently inhabited, and that conditions were practically unchanged since the previous visit (ibid. for 28 April 1911). The cutter anchored off Lisianski on 12 March 1913, and A. M. Bailey and G. Willett went ashore to examine the island (ibid. for 12 March 1913). The party liberated 45 Laysan Rails, collected some rabbits and one seal, and reported that conditions on the island were unchanged, except that there was a large increase in the number of rabbits found.

Bailey (1956) found the island a barren waste of sand, largely due to the destruction of the vegetation by rabbits. A couple of shacks, which had been built by the Japanese, were found. All of the sea birds seen on Laysan, with the exception of Fairy Terns and Red-tailed Tropicbirds, were noted, and, in addition, numerous Brown Boobies were observed.

Date?

When the Thetis next visited Lisianski on 12 September 1914 very few rabbits and turtles were seen, but terns and frigatebirds were numerous (Log of the Revenue Cutter Thetis for 12 September 1914). Carl Elscher, a chemical engineer, was aboard at this time, and reported (1915) that the island was dreary and desolate, with the only vegetation a single tobacco patch which had been planted by Schlemmer, and two small Ipomoea plants. He found only brackish water in the shallow wells. Only a few live rabbits were seen; they had apparently multiplied out of proportion to their food supply, eaten all the vegetation, and subsequently starved to death. He feared that the birds also were threatened with extinction.

The Thetis stopped at Lisianski on 24 March 1915, at which time the shore party reported large numbers of albatrosses, frigatebirds, boobies, terns, and shearwaters, saw very few rabbits, and noted that very little vegetation was left on the island (Log of the Revenue Cutter Thetis for 24 March 1915). Lt. W. H. Munter made detailed observations on the avifauna at this time (Annual Report of the Coast Guard for 1915, p. 134-136). The landing party was struck with the lack of vegetation; what little which was found was in very poor condition. The island was "wind swept, sandy, with bleached sea shells, and bird bones scattered everywhere." "A network of subterranean ... tunnels made by the petrels and shearwaters" made walking very difficult, "because every step or two one continually kept breaking through to the knee without the slightest warning into one of these burrows." Only seven rabbits were seen, all of which were captured and brought to the ship. A party landed on Lisianski from the Thetis on 5 February 1916, but there are no comments in the log as to the state of the island at that time (ibid. for 5 February 1916).

The Tanager Expedition landed on Lisianski on 15 May 1923 and remained until the 20th. Dr. Alexander Wetmore, in charge of the expedition, described the island (unpub. notes, 1923) as a parallelogram a nautical mile long by slightly less than a half mile wide. It was highest on the north and west where a rounded ridge rose to about 40 feet above sea level. Near the southern end of the island was a rounded central basin encircled on all sides by a low rim which separated it from the beach. This depression was dry, but was thought to be the site of an old lagoon similar to the one still found on Laysan. The soil was sandy, but with a high guano concentration that compacted it and stained it brown in places. On higher slopes the guano formed a firm crust that was either smooth or eroded in pits. A low ledge of limestone rock was found along the eastern shore. At the southern end of the depression Wetmore found the remains of an old Japanese camp. A shed about 30 by 12 feet had blown over, and only the corner posts marked the former sites of smaller buildings. About 30 rusted out five gallon coal oil tins lay about the camp. The frame of an old whale boat was found on the beach at the southwest corner of the island. A wrecked sampan and a dinghy were found south of the rocky ledge on the east beach. The sole vegetation of the island consisted of a grass plot of about three acres in a semicircle along the northern ridge, in which a few other plant species were also found.

The expedition surveyed the flora and fauna of the island, collected specimens, and planted several species of seeds and seedlings.

Personnel of the Bureau of Sport Fisheries and Wildlife made aerial surveys of Lisianski in December 1956, January, April, May, October, and December 1957, and January, April, May, and June 1958. Personnel of the Division of Fish and Game of the State of Hawaii visited the island on 9 March

1961.

The USS Duval County, LST 758, assigned to U. S. Navy, Commander Hawaiian Sea Frontier, visited Lisianski from 16 through 24 March 1961. Personnel from the office of Coast and Geodetic Survey and Hydrographic Office, Washington, D. C. and the Army Map Service conducted a reconnaissance of the island and established first order astronomic stations and HIRAN and Azimuth marks in connection with the Hawaiian geodetic survey.

Scientific Visits

The first visit to Lisianski of scientific importance was that of Herr C. Isenbeck, the German surgeon on the Russian exploring vessel Moller which visited the island in late March 1828. Isenbeck reported his findings to Herr F. H. von Kittlitz when the two met in Kamchatka several years later, and the latter published the information (Kittlitz, 1834). An English translation of Kittlitz's paper appears in The Avifauna of Laysan and the Neighboring Islands (Rothschild, 1893-1900). Isenbeck found twelve species of birds, including a duck and a rail, which were apparently the Laysan Teal and Laysan Rail, according to his species descriptions. He also noted sea turtles and seals.

The account of the wreck of the Holder Borden, Captain Jobish Pell, on Lisianski on 5 April 1844, contains two points of scientific interest. Pell mentions flocks of wild ducks, which were easily tamed, perhaps a second reference to the Laysan Teal on Lisianski. His account also includes a description of a swampy lagoon in the interior of the island, into which the highest tide occasionally flowed. (The Polynesian, 12 October 1844).

Lisianski - 1900 - 1930

The Guano-Cross and Feather-poaching Days

Visit of the Tanager Expedition

Lisianski - 1931 - 1959

Lisianski - 1960 - 1968

Visits by ^{the} Wildlife Bureau and the P.O.B.S.P.

Henry Palmer and George C. Munro, collecting for the Honorable Walter Rothschild of Tring, England, visited Lisianski in late June and early July 1891, and their findings are reported by Rothschild (op. cit.). Palmer found twelve species of sea birds and four of shore birds, seals and turtles, but does not mention a duck or a rail.

On 12 March 1913 A. M. Bailey and G. Willett landed on Lisianski from the Revenue Cutter Thetis. They liberated 45 Laysan Rails and made brief notes on the avifauna, which were later published by Willett (1919) and Bailey (1956). When the Thetis next visited the island on 12 September 1914 a chemical engineer, Carl Elschner, made observations on the geology, flora and fauna (Elschner, 1915). The Thetis next visited Lisianski on 24 March 1915 at which time First Lieutenant Munter made detailed observations on the avifauna (Annual Report of the Coast Guard for 1915 p. 134-136).

Accounts from other ship wrecks or visits to the island merely mention the presence of birds, seals and turtles, and lack ~~any~~ information of scientific value.

The Tanager Expedition, under the leadership of Dr. Alexander Wetmore, visited Lisianski from 15 through 20 May 1923. In addition to Dr. Wetmore, the party included Eric Schlemmer, his assistant; Dr. S. C. Ball, Bishop Museum; David Thaanum, conchologist; C. Grant, naturalist; John Baker, collector; and George Higgs, cook. As plants and insects were very rare the expedition's botanist and entomologist did not remain ashore. G. P. Wilder, Federal warden for the refuge, planted Barringtonia asiatica and other plants. Though no record was apparently kept of which species were planted on Lisianski, Dr. Wetmore has a list of the species given the expedition by the Department of Agriculture of the Territory of Hawaii for planting on the refuge. Of the ten species on

this list only three are growing on the island today.

The island was mapped, (Figure II) and collections were made of birds, mammals, insects, arachnids, plants, fish, molluscs, and many varieties of marine invertebrates. Twenty species of birds were noted by Wetmore (unpub. notes, 1923) and the bird and mammal life discussed briefly (Wetmore, 1925). The insects collected by the Tanager Expedition were described in papers by Timberlake (1924), Bryan (1926), Wheeler (1934), and Zimmerman (1948). Christophersen and Caum (1931) reported that the vegetation was "exceedingly poor, one patch of grass at the north end a few other plants sparsely distributed being all that was to be found." Four species of vascular plants were collected. Fish specimens collected by the expedition have been discussed by Fowler and Ball (1925) and Fowler (1927, 1928, 1931, 1934, and 1949). The Crustacea were treated by Edmondson (1925), the Echinodermata by Fisher (1925) and Clark (1925 and 1949), and the Foraminifera by Cushman (1925). Thompson (1938) and Bequaert (1941) discuss the Hippoboscidae collected by the expedition. Frank Richardson of the University of Washington visited the island on 26 March 1954, and has kindly made his population estimates available to the POBSP.

Personnel of the Bureau of Sport Fisheries and Wildlife made aerial surveys of Lisianski in December 1956, January, April, May, October and December 1957, and January, April, May and June 1958. Their observations are reported in papers on the Hawaiian monk seal (Kenyon and Rice, 1959) and the albatrosses (Rice and Kenyon, 1962).

Personnel of the Division of Fish and Game of the State of Hawaii visited the island on 9 March 1961. They made general observations on the wildlife, surveyed the possibilities for the introduction of Laysan Teal, set up photographic stations, and set up refuge signs. Their observations were presented

Figure II

Lisianski Island 1923

On this beach
①, About 300 yards south of the ledge, a ^{Cross section of} ~~large segment~~ a log, 6 feet in diameter and
by boobies for roosting sites on the edge of the beach. (see figure -)

To the north of this and the terrain above the beach is reasonably level while to the south the terrain is composed of low rolling sand dunes to about 10 feet high and covered principally with *Scaevola*

in two unpublished reports (Woodside and Kramer, 1961, and Kramer and Woodside, 1961) to the Division of Fish and Game. One member of the Division accompanied the POBSP to the island in February 1963 and submitted a separate report (Kramer, 1963) to that agency. *which agency?*

Pacific Ocean Biological Survey Program personnel have spent a total of 15 days on Lisianski on seven different trips since February 1963. Personnel from the Bureau of Sport Fisheries and Wildlife, and the Division of Fish and Game of the State of Hawaii have been present on several of these trips. Dates and personnel for each visit are listed in Table I. Population estimates and breeding notes are available from each trip, though limitations of time precluded thorough observations on some visits.

Description

Lisianski (Figure III) is a low sand and coral island of approximately 454 acres. ^(cite) It is situated at the northern end of a large reef bank which is about 65 square miles, or 41,322 acres, in area. ^{0.15} The island, resembling a parallelogram in outline, is approximately 2000 yards long, north to south, and 1100 yards wide, being somewhat wider to the north. Its circumference is about 3.23 statute miles.

The ^{North} eastern beach is dominated by an exposed ledge of reef rock, with small tidal pools, behind which a narrow rocky beach rises sharply for about ten feet to the vegetated interior. South of the rock ledge a low curving beach extends to the southeastern corner. There is a vertical drop of about ^{five} ~~three~~ feet, caused by wind and wave erosion, from the vegetated interior to this beach. The beach widens at the southeastern corner, and there is a large unvegetated cut into the Scaevola behind this beach. ^(fig -) ~~The beach on the~~ ^{about 225} feet across at its mouth and extending about ~~100~~ feet into the Scaevola ^(fig.)

Pacific Ocean Biological Survey Program Surveys of Lisianski Island *

<u>Trip Designation</u>	<u>Inclusive Dates of Survey</u>	<u>Personnel</u>
LS 1 [1.4]	14 February 1963 (1000-1630)	William O. Wirtz II (Leader), A. Binion Amerson, Jr., F. Allen Blagden, Robert W. McFarlane, Fred C. Sibley (POBSP), Ronald J. Kramer (HFG)
[1.8]	12-13 March 1963 (1830-0830)	William O. Wirtz II (Leader), A. Binion Amerson, Jr., Robert W. McFarlane (POBSP)
LS 3 [1.8]	11-12 March 1964 (2000-1700)	A. Binion Amerson, Jr., (Leader), George S. Wislocki (POBSP), Eugene Kridler, Edward O'Neil (BSFW) Ronald E. Walker (HFG) Loren Kroenke (UH)
LS 4 [9.4]	21-23 August 1964 (0900-0600)	Kenneth E. Amerman (Leader), Alan H. Anderson, Richard W. Merrill, J. Douglas Whitman, Paul W. Woodward (POBSP) Alan Lee Young, Robert Banner (UH)
LS 5 [0.8]	18 September 1964 (0900-1800)	Robert R. Fleet (Leader), Charles R. Long (POBSP) Eugene Kridler (BSFW) Ronald E. Walker (HFG) John Beardsley (UH)
LS 7 [10.8]	12-14 March 1965 (1100-1500)	William O. Wirtz II (Leader), Kenneth E. Amerman, Roger B. Clapp, J. Vin Hoeman, Dennis L. Stadel (POBSP), Charles Williams, Jr. ()
LS 9 [10.9]	14-17 July 1965 (1130-0500)	Dayle N. Husted (Leader), Richard S. Crossin, Brian A. Harrington, Jeffrey P. Tordoff (POBSP)
LS 13 [22.6]	16-19 June 1966 (1630-2130)	Richard S. Crossin (Leader), Kenneth C. Balcomb (Assistant Leader), Richard D. Chandler, David I. Hoff, David L. Pearson, Philip C. Shelton, Frank H. Smith, Jr. (POBSP)
LS 17 [6.1]	18-20 October 1966 (0945-0800)	Kenneth C. Balcomb (Leader), Patrick J. Gould, Brian A. Harrington, T. James Lewis (POBSP)
LS 18 [0.3]	20 March 1967, (0900-1630)	C. Douglas Hackman (POBSP), Eugene Kridler, John Maciolek (BSFW) Ernest Kosaka (HFG) Richard Wass (UH)
LS 19 [21.7]	2-6 June 1967 (1000-1800)	Robert L. DeLong (Leader), David Burckhalter, Dennis L. Stadel, Frank C. Thompson, Robert Tuxson (POBSP)
LS 20 [13.6]	31 Aug.-5 Sept. 1967 (1130-0730)	Charles A. Ely (Leader), Roger B. Clapp, David I. Hoff (POBSP)

* Beneath the trip designation is given the approximate number of man-days spent on the island by POBSP personnel during each visit. Beneath the dates are the times of arrival and departure. Abbreviations are as follows: POBSP (Pacific Ocean Biological Survey Program); HFG (Hawaiian Fish and Game Department); BSFW (Bureau of Sport Fisheries and Wildlife); UH (University of Hawaii).

Table I: Dates and personnel of visits by the Pacific Ocean Biological Survey Program

14 February 1963	W. O. Wirtz II, F. C. Sibley, A. B. Amerson, Jr., R. W. McFarlane, F. A. Blagden (all POBSP)
12-13 March 1963	W. O. Wirtz II, A. B. Amerson, Jr., R. W. McFarlane (all POBSP)
11-12 March 1964	A. B. Amerson, Jr., G. S. Wislocki, POBSP; R. E. Walker, Hawaii Division of Fish and Game; E. Kridler, E. O'Neil, Bureau of Sport Fisheries and Wildlife; L. Kroenke, University of Hawaii
21-23 August 1964	K. E. Amerman, P. W. Woodward, R. W. Merrill, P. Marshall, A. Anderson, POBSP; A. Young, University of Hawaii
18 September 1964	R. R. Fleet, C. R. Long, POBSP; R. E. Walker, Hawaii Division of Fish and Game; E. Kridler, Bureau of Sport Fisheries and Wildlife; J. Beardsley, University of Hawaii
12-14 March 1965	W. O. Wirtz II, K. E. Amerman, R. B. Clapp, J. V. Hoeman, D. L. Stadel, (all POBSP)
14-17 July 1965	D. Husted, R. Crossin, B. Harrington, J. Tordoff, (all POBSP)

Figure III

Lisianski Island 1942

The beach on the south end of the island

23

southern side is narrow to the east and wide and curving to the west.

~~It is composed of fine sand which is blown and ridged into the Scaevola,~~
indicating that the island frequently receives winds from the southeast.

There is a ^{seven} three foot vertical drop from the vegetated interior to the

beach at the eastern corner of the southern beach. ^{Just west} West of this area a ~~curve of dunes about 20 feet high extends down to the beach line from the~~
^{series of dunes rise to 20 feet or more, an area that now appears to}
~~be the high point of the island.~~

~~north and then turns west along the beach line and back north again along~~

~~the southwest beach.~~ ^{These rolling dunes, gradually decrease in height}
~~There is a slight indentation in the western portion~~
^{as one moves along the south end of the island and}
~~of this beach, but the shoreline is subject to periodic changes in outline.~~
^{to the southwest beach.}

The beach along the west side of the island is fairly steep, and there is

a slight vertical cut and overhang at the edge of the vegetated area where

erosion has occurred. The sand of the beach is hard-packed. A definite

cove is present near the middle of the west beach, ^{which} This area is designated

as a small boat landing on the hydrographic charts. There are only a few

small coral heads in the lagoon area west of the landing, and a large area

of clear green water lies between the landing and the edge of the reef rock

to the west. North of this cove the beach curves toward the northwest. It

is still fairly steep and hard-packed in this area. The beach on the north-

west side of the island is 20 to 30 yards wide and slightly inclined up to

the vegetated interior. Coral rubble is scattered in the sand, and several

very large tree trunks are buried in the beach here. After the straight

beach on the northwest side of the island there is a crescent-shaped beach

about 100 yards long, curving toward the east. The beach here is also 20 to

30 yards wide and has coral rubble. There is a slight drop from the interior

to the beach here. The beach around the northeast corner is an inverted

crescent, and the island curves around to the east and then southward to the

northern end of the rocky ledge. The beach in this section is composed of hard sand for about 15 yards from the water. Above this line there is more coral rubble mixed with the sand. The beach becomes steeper and narrower around the northeast corner.

A fairly dense growth of Scaevola grows at the perimeter of the entire island, punctuated in a few places by sandy cuts. There are some areas of Scaevola in the interior, notably in the north and east. (Bunchgrass (Eragrostis variabilis) and vines usually occur in association with the Scaevola.) The interior of the island is covered primarily with a lush growth of bunchgrass (Eragrostis) growing to a height of three feet or more, with several other associated plants. There are several large nearly pure stands of morning-glory (Ipomoea) notably in the south in the central depression, and at the north end, interspersed with the bunchgrass. (Figure P14) Two large palm trees grow about 100 feet inland from the beach in the northeast section, and a few hundred feet south of them. There is a small group of ironwood trees (Casuarina) just north of the cove on the west side, one dead one at the southwest side, another small group of ironwoods is found at the north end of the west cove, a live and a dead and a live and dead tree are found together towards the south end of the island. Another large dead ironwood, much used for

According to a topographic study by the U. S. Coast and Geodetic Survey in 1930 and 1931 (Figure III, USCGS 4186, 1942) the topography of the island is dominated by a crescent-shaped ridge which extends from the northeast side of the island around the north and down the west side to the southwest corner. USCGS 4186 has contour lines at ten and fifteen feet in this ridge, and a high point of twenty feet at its eastern end. A second ridge along the southern side of the island and curving northward at the southwest and southeast corners is currently [1963] obvious, and is figured on a map of the island made in 1923. (Figure II) D 15) D 16)

← roosting by ~~boobies~~ Red-footed Boobies and frigatebirds, is found to the southwest of the latter group.

This map, (Bryan, 1938) made by the Tanager Expedition in May 1923, shows the northern two-thirds of the island to be dominated by a large crescentic ridge with a maximum height of 30 feet along the western beach and 40 feet above the northeastern beach. A small crescentic ridge, with a maximum height of 20 feet, extends from east to west across the southern end of the island. A rocky ledge, in three portions, is figured along the southern half of the east beach.

The only vegetation on this map is a patch of grass, about 800 feet by 250 feet, in the northwestern portion of the island. The ruins of Japanese shacks are figured north of the southern ridge, and the wrecks of a sampan and a dingy are noted above the southeast beach, and that of another sampan above the southwest beach.

Wetmore (unpub. ^(ms) notes, 1923) described the island in May 1923 as absolutely devoid of vegetation except for a narrow strip of grass and pigweed about two acres in area along the ridge at the northwest corner of the island. "It is roughly a parallelogram a nautical mile long by slightly less than a half mile wide. A low ridge on the northeast marks the highest point and there is a central depression bounded by a raised rim protecting it from the ocean that must in an earlier stage of development have been the basin of a lagoon similar to that at Laysan".

Captain Jobish Pell of the Holder Borden, which wrecked on Lisianski in April 1844, described a swampy lagoon covered with grass in the interior of the island, into which the highest tides occasionally flowed (The Polynesian, 12 October 1844). This account provides the only known description of an actual lagoon on the island. There is no mention of a lagoon in the accounts of Isenbeck (Kittlitz, 1834) or Palmer (Rothschild, 1893-1900). As the

lagoons on Laysan and Lisianski are (or were) apparently fed by abnormally high winter tides (Warner, 1963) and rainfall it seems reasonable to suppose that the lagoon on Lisianski could have dried up during a series of mild winters and been refilled during a series of severe ones. This hypothesis could explain the description of a swampy lagoon in 1844 and no mention of one in 1828 or 1891.

Hydrographic Office Chart 4, issued in August 1924, (Figure IV) indicates a prominent crescent-shaped ridge just inside the north and east beaches from the northwest corner to the southeast corner. The maximum elevations along this ridge are 44 feet in the northern portion and 35 feet in the southern section. The positions of three separate pockets of guano across the southern end of the island are indicated on this chart. No trees or other prominent land marks are figured.

Vegetation

A summary of the vegetation of Lisianski ^{in 1923} ~~appeared 34 years ago~~ ^{was reported} (Christophersen and Caum, 1931). This account described the vegetation as ~~observed in 1923-24 during the Tanager Expeditions.~~ In 1923-1924² four species of plants were collected: Eragrostis, Sesuvium, Nama and Portulaca. Three of the species collected by the Tanager Expedition are still found; Eragrostis, Nama and Portulaca. Of the 13 species recorded for the island in 1923, Nicotiana and Sesuvium are no longer found, and seven species recorded in 1963-64 were new records for the flora of the island.

The earlier reports of Lisiansky (1814), and Walker (1909) are summarized in Christophersen and Caum (1931). These indicate a well vegetated island which was later stripped of vegetation by introduced rabbits in the first decade of the twentieth century. A later work (Bryan, 1942) summarizes the

Figure IV

Lisianski Island 1924

observations of other early visitors as follows: Paty (1857) "coarse grass," Brooks (1859) "shrubs", and cites Elschner (1915) that some guano was shipped from the island. Christophersen and Caum, (op. cit.) report that the vegetation was "exceedingly poor, one patch of grass at the north end and a few other plants sparsely distributed being all that was found." Four photographs have been found in the library of the B. P. Bishop Museum (Numbers 10077, 10079, 10081 and 10084) which show clumps of Eragrostis, nests of Great Frigatebirds built of sticks on the soil surface, a barren panorama with no vegetation, and strand site with Boerhavia and perching noddies.

In 1964 the vegetation was thick and composed of three major associations. These were Scaevola - Eragrostis with Ipomoea, Sicyos, Boerhavia and Tribulus; Eragrostis - Boerhavia; and Nama. These associations formed concentric bands. The Nama was found on the sandy periphery, but was absent on the west side due to a shift in the substrate materials. The Scaevola grew over most of the elevated portions of the island and the Eragrostis in the low central area.

The vegetation of Lisianski Island has evidenced a cyclic pattern of complete devastation and recovery in three score years. The thick vegetation noted in 1964 infers that the factors influencing distribution and, or recovery of plant species on oceanic islands, especially low sand atolls or islets, are most efficient. The sequence of species introduction and association development recorded for Lisianski Island confirms previous speculation on pioneer species and rapidity with which vegetation can recover from denudation. In cases where storms are responsible for elimination of

the vegetation we might expect the recovery to take longer due to the concomitant movement of substrates.

Thirteen species of vascular plants have been recorded from Lisianski Island. Vascular plants have been collected by the following: G. P. Wilder, May 1923; F. C. Sibley, June 1963; A. Young, August 1964; and C. R. Long, September 1964. These collections are housed in herbariums of the United States National Museum (USNM), the B. P. Bishop Museum (BISH), and the University of Hawaii (UH).

Gramineae

Eragrostis variabilis (Gaud.) Steud.

Wilder 5,7 (BISH), Young 132 (UH), Long 2316 (UH). Found on most of the inner portions of the island commonly with Boerhavia and Ipomoea in the central open area and in open Scaevola thickets. Often in pure local stands above the beach. Seedlings common especially on sand mounds on the interior as the result of shearwater burrowing.

Palmae

Cocos nucifera L.

Two trees on the east side were observed in 1964.

Casuarinaceae

Casuarina equisetifolia L.

Sibley 100 (USNM), Young 133 (UH). Four trees were observed in 1964. One was dead on the southwest side. Used as a perch by fairy terns, boobies, noddies and frigatebirds.

Nyctaginaceae

Boerhavia diffusa L.

Sibley 101 (USNM), Young 134 (UH), Long 2321, 2324, 2328, 2336, 2350 (UH). Found over most of the island. In Scaevola thickets the stems grow over the surface of the lower shrubs. This species appears to be a pioneer in sandy areas. Flowers vary in color from a lavender-pink to white. Many seedlings observed in 1964.

Aizoaceae

Sesuvium portulacastrum L.

Wilder 6 (BISH). Only one collection exists. It is possible that during the denudation of the island the sites on which this common species is usually found were drifted with sand, thus closing the preferred ecological niche of a thin soil over a moist coralline hardpan.

Portulacaceae

Portulaca lutea Sol.

Wilder 9 (BISH) as P. oleracea, Young 138 (UH), Long 2333 (UH). The Wilder collection was evidently misplaced since Christophersen and Caum mention only a field label. Found in sandy peripheral areas in 1964 but not common. Some seedlings were observed in these areas.

Leguminosae

Young 137 (UH). A sterile specimen which resembles Canavalia or Vigna.

Zygophyllaceae

Tribulus cistoides L.

Sibley 102 (USNM), Young 139 (UH), Long 2348 (UH). Common in sandy soil of the island rim with Ipomoea, Eragrostis and Boerhavia.

Convolvulaceae

Ipomoea indica (Burm. f.) Merr.

Sibley 103 (USNM), Young 140 (UH), Long 2339, 2349 (UH). Common as climber over Scaevola or in dense patches over Eragrostis in the central clearing. Flowers blue fading to white.

Ipomoea sp.

Reported by Elschner (1915).

Hydrophyllaceae

Nama sandwicensis var. laysanicum Brand.

Wilder 8 (BISH), Young 136 (UH), Long 2325, 2331 (UH). In sand on the south, east and north sides of the island. Many seedlings observed in 1964. Often occurs with Boerhavia.

Solanaceae

Nicotiana tabacum L.

Reported by Elschner (1915). Not found in 1964. This species has naturalized on Laysan Island.

Solanum nigrum L.

Long 2318 (UH). Several plants were growing in gravel pockets of coral rock just above the high water line on the east side. Small plants with flowers and fruits were collected.

Cucurbitaceae

Sicyos hispidus Hbd.

Young 135 (UH), Long 2314, 2315, 2317, 2356 (UH). Common over Scaevola on the east and northwest sides. Abundant.

Goodeniaceae

Scaevola taccada (Gaertn.) Roxb.

Young 131 (UH), Long 2322, 2326, 2330, 2334, 2340, 2353 (UH). The predominant species on the island. Large amounts of material of this species have been collected from the Hawaiian Leeward, Phoenix and Line Islands in order that estimates of variability can be determined.

*as in the
Hawaiian
Islands*

Geology

The Hawaiian Islands are the summits of a range of volcanic mountains that stretches for more than 1500 nautical miles in a southeast-northwest direction across the floor of the North Pacific Ocean. The entire chain is normally divided into two groups. The islands from Niihau and Kauai southeast to Hawaii are considered the main or windward group, while the tiny points of protruding land from Nihoa northwest to Kure are called the leeward group. There are many papers dealing with the geological history of the group, including Bryan (1915), Stearns (1946), and Zimmerman (1948), but there are no papers that deal specifically with the geology of Lisianski Island.

Geological evidence suggests that the range was formed during the Tertiary Period, and that the peaks at the northwestern end of the chain were formed earlier than those to the southeast (Zimmerman, op. cit.). The islands were built of successive flows of basalts and volcanic products through a fissure in the ocean bottom, some 15,000 to 18,000 feet below the present surface.

Stearns (op. cit.) describes the formation of these volcanic islands as occurring in several stages. During the submarine stage, development is due primarily to the addition of quantities of pillow lava and the production

of ash and pumice as a result of the contact of magma with sea water. This soft cone is easily eroded by the sea when the peak reaches sea level. A shieldshaped dome is built from thin sheets of highly fluid olivine basalts once the cone reaches sea level. The volcano gradually collapses over the vent areas to form a caldera on the summit, and as fresh lava pours from the cone this caldera is obliterated. Erosion partly destroys the volcanic dome, and submergence may drown the dome and provide an environment suited to the development of coral reefs. Rejuvenation of volcanic activity may destroy coralline growth and the island may continue to emerge, as in the case of the main islands. Or submergence or erosion may continue with the subsequent development of an atoll.

Erosion by wind, waves and rain reached its maximum in the fluctuating seas of the Pleistocene, when geological evidence suggests that the sea may have been 1000 feet lower than it is today (Zimmerman, op. cit.). When the sea rose slowly as the glaciers receded a littoral environment suitable for the growth of coral was provided by the eroded mountain peak. Coral growth is limited by depth due to light and oxygen requirements (Wiens, 1964), so that growth had to keep pace with the rising sea to survive. At equilibrium a rim of coral remained, enclosing a lagoon on top of the peak, and larger areas of coralline growth could then erode and begin the long process of soil formation and plant establishment that has created the existing islands of the Leeward Chain.

Soils on Lisianski range from pure sand and coralline gravel on the beaches, through coarse coral rock areas above the beach zone, to humus-sandy mixtures in the vegetated areas. Elschner (op. cit.) reported that the surface was bleached sand to four or five centimeters, and that the deeper strata were moist and gray. There are no more recent soil determinations

for the island.

Elschner (ibid.) reported that the entire surface was partially phosphatized, there being a more or less fine film of phosphates on all sand particles. He noted that the former lagoon was visible as a basin, and that the best guano was found in this area. Phosphate determinations [as $\text{Ca}_3\text{P}_2\text{O}_8$ in the original] by Elschner varied from 2.12 to 11.12 percent in surface sand and from 14.24 to 62.17 percent in the area of the former lagoon. Walker (1909) estimated that there were 1000 tons of guano on the island in June 1891, but Elschner (op. cit.) notes that only the best guano had been shipped prior to his visit in September 1914. Guano operations were conducted on Lisianski from about 1903 to 1908.

Climate

Climatic data for this area of the Pacific are available only from Midway Naval Station, 255 miles northwest of Lisianski. No significant difference is expected between the general weather conditions of the two islands. The data used in this section are from a summary of the years 1953-1963 (NavSta Midway Forecast Handbook and Air Weather Service, [MATS] Climatic Center USAF).

Climate in this region of the Pacific is marine, influenced by marine tropical or marine Pacific air masses depending upon the season. During summer the Pacific High becomes dominant, with the ridge line extending across the Pacific north of Midway. This places the region under the influence of easterlies with marine tropical and trade winds prevailing. During the winter, especially from November through January, the Aleutian low moves southward over the North Pacific, displacing the Pacific High before it. The Midway region is then affected by either marine Pacific or marine tropical air, depending upon the intensity of the Aleutian Low

and, or the Pacific High.

Monthly maximum, minimum, and mean temperatures for a ten year period are shown in Figure V. The temperature variation shown is indicative of a marine environment. The mean annual range is 16°F . From December through April the means range between 66°F and 69°F , and during the remainder of the year between 70°F and 81°F , the warmest months being July, August and September, and the coolest January, February and April. An inexplicable departure from the normal curve occurs in maximum, minimum and mean figures for April. A 37 degree difference exists between the absolute high of 89°F and the absolute low of 52°F for this ten year period.

Mean monthly precipitation and the number of days with measurable precipitation are tabulated in Figure VI. Rain or drizzle most frequently occur from December through May, and least frequently in June and July. The mean annual precipitation for the period is 42.59 inches, with a maximum of 5.07 inches occurring in January and August, and a minimum of 2.03 inches in November. A secondary maximum of 4.92 inches occurs in October. Combining amount of precipitation and days with measurable precipitation shows May and June to be the driest months of the year. During the remaining months measurable rain falls on from 10 to 17 days. No snow has been recorded. Thunderstorms have been recorded in all months except February, March and April but peak activity seems to occur during August, September and November. The annual average relative humidity is 76 percent with a high monthly mean of 89 percent and a low of 62 percent.

During the periods for which data are available no tropical storm or typhoon has passed through the area, though storms of tropical

Temperature
Figure II: The mode of the monthly means for a ten year period, 1953-63, and the range of the maximum and minimum modes of temperatures for Midway Atoll.

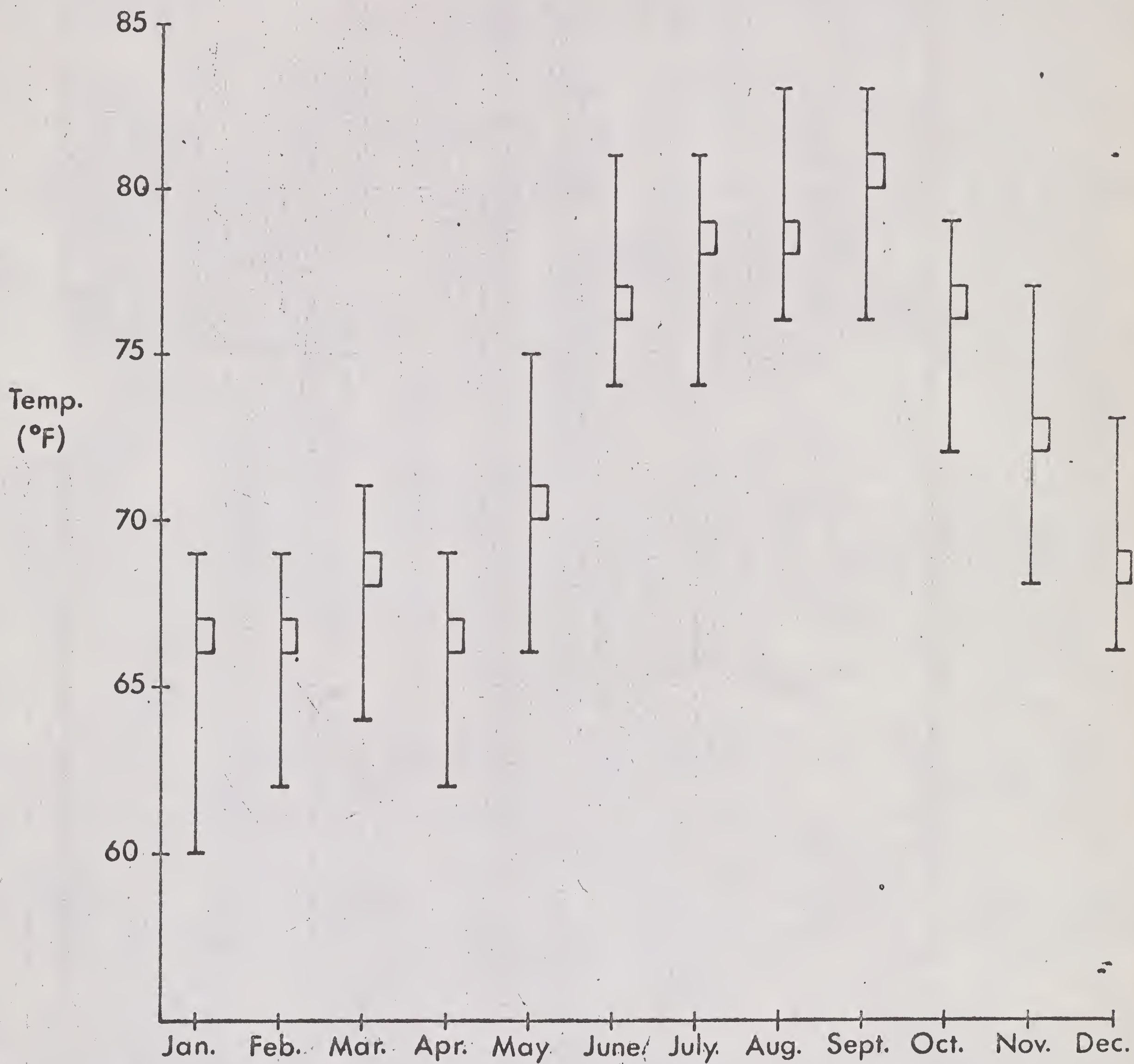
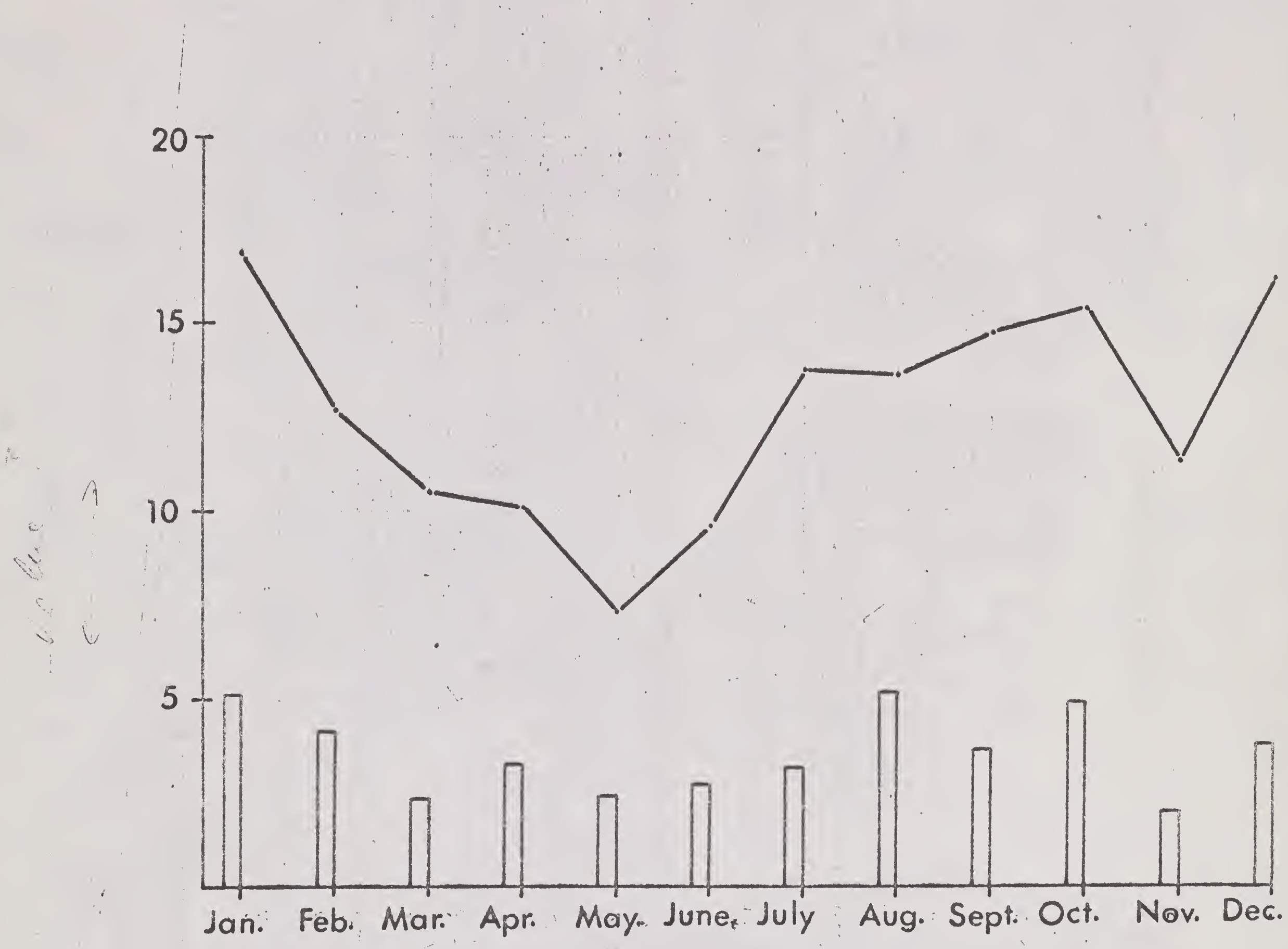


Figure III: Mean monthly precipitation in inches (histogram) and mean number of days with measurable precipitation (line graph) for Midway Atoll, 1953-63.



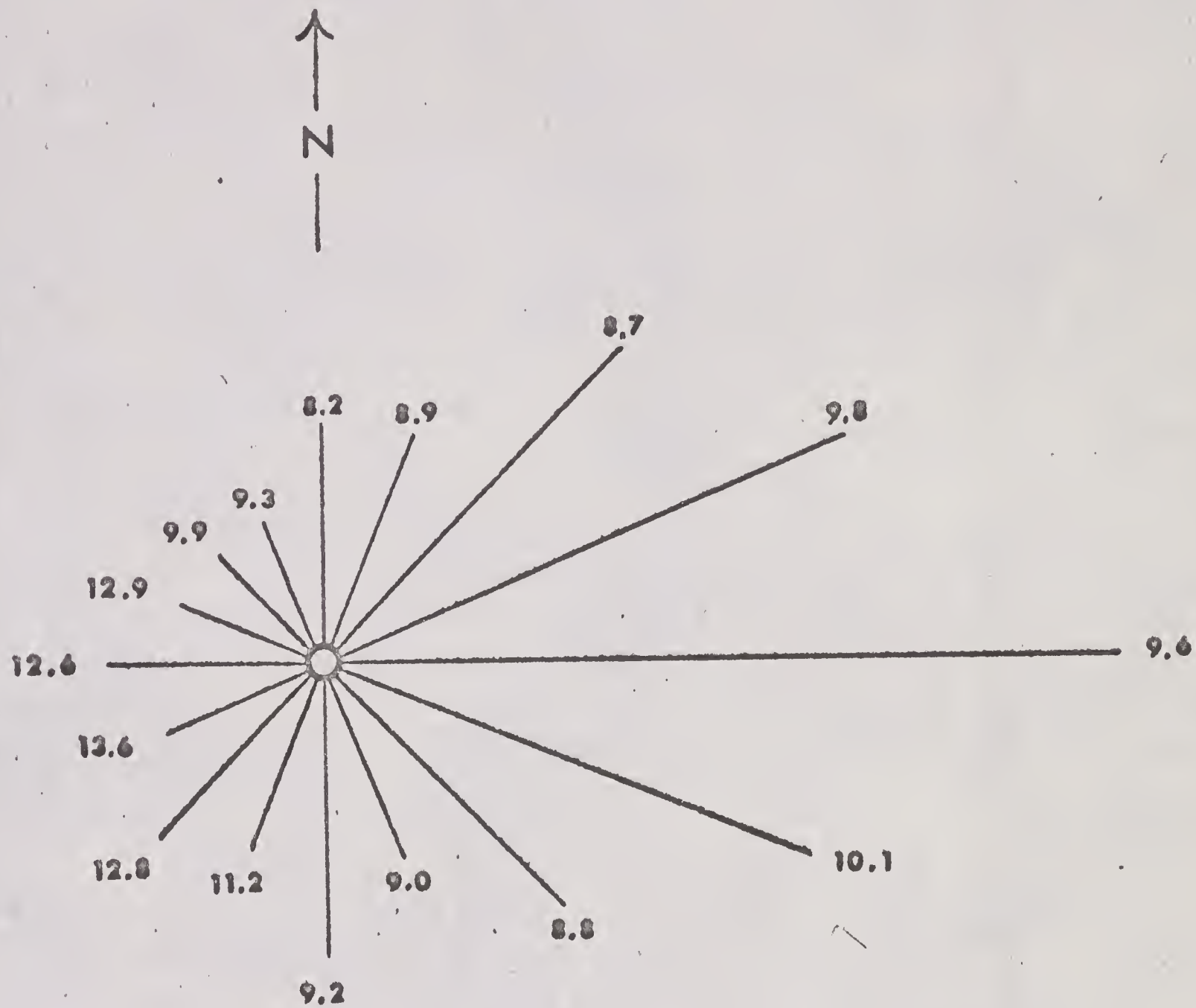
character have passed within 500 miles, causing a noticeable increase in precipitation and winds, especially in September of 1957, 1958 and 1959, October and November 1962, and December 1964.

The maximum sustained wind recorded for Midway is 44 knots in January. Maximum winds are lowest in June, July and August, are high in September and December, and also low in October. Maximum winds occur generally from the east from July through October, and from the west the remainder of the year. Peak gusts of 77 and 67 knots have been recorded in December and January respectively, during the period when the Easterlies are not present. From May through August peaks range from 35 to 41 knots and in the remaining months from 42 to 55 knots. Gusts are generally from the west.

Surface wind speeds and directions are shown in Figure VII. The prevailing wind direction ten months of the year is the easterly, and during December and January westerly. The annual mean wind speed is 10 knots, with a range of 5 knots. No sustained winds over 40 knots have been recorded. Winds of over four knots generally range from northeast to southeast, while greatest mean wind speeds are recorded from south-southwest to west-northwest.

The mean tenths of total sky cover is fairly uniform throughout the year, ranging from a low of 5.3 in August to a high of 7.3 in March. The yearly mean is 6.2. The occurrence of fog and haze is negligible, but highest in January and March. Closed conditions with visibility less than one mile occur rarely (2 ^{percent} ~~per~~) at Midway, but most often from December through April, when due to rain.

Figure IV: Wind direction and speed at Midway Atoll, 1953-63. Length of directional line indicates percent of observations from that direction; figure at end of the directional line is mean wind speed in knots.



Hawaiian Monk Seal (Monachus schauinslandi)

Current Status: Resident.

Prior Records: Captain Urey Lisiansky found seals seven feet long on the island when he discovered it in October 1805 (Lisiansky, 1814). Ship's officers killed four of them. Herr C. Isenbeck found several small seals on the island when he visited it in March 1828 (Rothschild, op. cit.). Captain John Paty (op. cit.) stopped there in May 1857 and reported seals. Palmer and Munro collected a seal on Lisianski in early July 1891 (Rothschild, op. cit.), but the skin was lost. Captain F. D. Walker of the schooner Kaalokai, on which Palmer and Munro visited the islands, reported (1909) "seals sleeping on the sand beach one hundred feet wide." John Cameron (1928) stopped twice at Lisianski some time in the 1880's and 1890's to kill seals for meat. Wetmore (unpub. notes, 1923) found a few on the island in May 1923, and collected two specimens. Kenyon and Rice (1959) made aerial surveys of the island in January and April 1956. They reported (ibid.) 241 adults and 15 pups by 15 April 1956. Woodside and Kramer (1961) counted 172 adults and found one dead pup in March 1961.

Population: The survey has counted seals on each visit. On the basis of actual counts the resident herd is between 150 and 200 animals. However, data collected on Kure Atoll by the POBSP suggest that only one-fourth to one-third of the resident herd is on the beach at any one time. If this hypothesis is proven the resident herd at Lisianski contains 450 to 800 animals. Beach counts taken by the survey are: 209 adults, one pup and one dead pup in March 1963; 173 adults and 7 pups in March 1964; 143 adults and one pup in August 1964; 121 adults in September 1964; 172 adults and 15 pups in March 1965; and 161 adults in July 1965.

Reproduction: Kenyon and Rice (1959) found 15 pups in April 1957. The PCBSP found one live and one dead pup in March 1963, seven in March 1964, and 15 in March 1965. One was seen in August 1964.

The pupping season on Kure Atoll, 300 miles to the northwest, extends from mid-February to early June. The gestation period is unknown.

European Rabbit (Oryctolagus cuniculus)

Current Status: Extinct.

Prior Records: Rabbits were evidently introduced to Lisianski in 1903.

This was shortly after their introduction to Laysan by Max Schlemmer, the manager of the guano station there. Alfred M. Bailey (1952 and 1956) and George Willett visited the island briefly in March 1913. They found that it was rapidly being turned into a desert by the depredations of the multiplying rabbits. When Carl Elschner (op. cit.) visited the island briefly in September 1914 he found it "dreary and desolate" with the only vegetation a single patch of tobacco which had been set out near the house by Schlemmer, and two sickly Ipomoea plants. Very few live rabbits were found, but the total destruction of the vegetation seriously threatened a party from the Thetis saw only seven animals in March 1915, the existence of the remaining birds. When the Tanager Expedition arrived all of which were captured (Munter, op. cit.). In May 1923 the rabbits were dead, having destroyed their food source and themselves in the ultimate process (Wetmore, 1925).

Rat (Rattus sp.)

Current Status: Extinct.

Prior Records: No living animals remain on Lisianski today, and there are no specimens of an animal vaguely, but quite vividly, reported from the island in the last century.

Some time in the 1890's John Cameron, a sailor and adventurer, visited the island and reported "myriads of mice" (Cameron, 1928). A quote from his book (ibid.) perhaps best describes the situation he found.

"We had settled ourselves for an appetizing supper of fresh food when myriads of mice attacked our meal ravenously and utterly without fear. Drive them away we could not; we slaughtered them by hundreds, yet they would not be denied. A full hour elapsed before we could eat in some semblance of peace; then each of us had to hold his food in one hand and a stick in the other. During the night the pests continually galloped over us; they did not, however, bite us, though that seems remarkable, since there was little on the island for them to eat, unless they devoured one another."

There is the possibility that Cameron was in error about which island the mice were on, for no one else has ever reported rodents of any kind on Lisianski. His book is almost entirely without dates, and was completed from his journal after he had died. He describes a lagoon with large rocks at Lisianski (pages 234 and 397) which does not exist today, but his description of the island itself, and its position 125 miles west of Laysan (page 397) is valid. Thousands of Polynesian rats occur today on Kure Atoll, 300 miles to the northwest, which does have a lagoon similar to the one Cameron described for Lisianski. It is possible that he mixed the rats and lagoon of Kure with the island of Lisianski.

Birds

Information on the avifauna of Lisianski is available from numerous sources, beginning with the observations of Isenbeck in March 1828 (Kittlitz, 1834 and Rothschild, 1893-1900). Rothschild (op. cit.) reports both the species accounts and the field notes of his collector, Henry Palmer, who

visited the island from 29 June to 4 July 1891. Bailey (1956) reports his observations, and those of George Willet, which were made in March 1913, and Munter (1915) reports his observations made in March 1915. Limited information is available from the accounts of several ship wrecks or visits to the islands in the last century. The ornithological data from the Tanager Expedition, which visited the island in May 1923, are found primarily in the unpublished field notes of Dr. Alexander Wetmore, which he has kindly made available to the POBSP. The data from aerial surveys by personnel of the Bureau of Sport Fisheries and Wildlife are presented in papers by Kenyon and Rice (1959), and Rice and Kenyon (1962). Surveys by personnel of the Division of Fish and Game of the State of Hawaii are reported in unpublished manuscripts to that agency by Woodside and Kramer (1961), Kramer and Woodside (1961), and Kramer (1963).

Prior to 1963 fifteen species of breeding sea birds and seven species of migrants, land birds, or accidentals had been recorded for the island. The POBSP has added one species to the list of breeding sea birds and six species to the list of migrants or accidentals. The two species of land birds formerly reported have not been found.

The following annotated species accounts include not only all POBSP data but also all known literature references and unpublished material. Population estimates and breeding information from Munter (1915), Wetmore (unpub. notes, 1923), and all POBSP visits are summarized in Table II, and discussed in the text. Population figures are estimates unless stated to be actual counts. The breeding data are not adequate to delineate with certainty the breeding cycle of each species on Lisianski. When such data are available from POBSP studies on Kure Atoll, 300 miles to the northwest, they are included in the text under the section on reproduction. Table III

Table II: Population Estimates and Breeding Information from Munter (1915), Wetmore (1923), and the Pacific Ocean Biological Survey Program for Lisianski Island. (* indicates actual count, A- adult, I- immature, N- nestling, E- nests with egg or eggs).

	March 1915	May 1923	March 1963	March 1964	August 1964	September 1964	March 1965	July 1965
Black-footed Albatross	8,000 A Numerous N	2,000 A	Thousands, with N	10,000 A 1,750 N			3,500 A 1,300 N	200 N
Laysan Albatross	10,000 A Numerous N	1,600 A	Thousands, with N	8,500 A 2,600 N	30 N*		8,000 A 2,750 N	2,000 N
Wedge-tailed Shearwater	15,000 A	25,000 A	1 A*	25 A	40,000 A 10,000 I	30,000 A Many N	150 A	45,000A
Christmas Island Shearwater	10,000 A	600 A E	15 A*		1 N*	3 A*	750 A	400 A
Bonin Island Petrel		50 A	Abundant, with E	100,000 A E, N (?)	15,000 A	3 A*	1,000,000 A with E, N	200 A
Red-tailed Tropicbird		2 A*	Present	125 A	300 A 140 N 10 E	50 A 5 I*	25 A 1 E*	1,000 A 200 N
Blue-faced Booby	Numerous E, N	200 A	500 A, E, N	575 A 100 N 100 E	500 A 100 I 1 N*, 1E**	250 A 54 I*	875 A 100 E	300 A 100 N
Brown Booby	85 A E, N	80 A E, N	30 A 1 I*	17 A	50 A	25 A 1 I*	25 A 1 E*	100 A 20 N
Red-footed Booby	10 A E, N	25 A 2 E*	50 A, E	450 A 125 E	300 A	400 A 103 I* 17 N*	1,000 A few E	500 A 200 N
Great Frigatebird	3,500 A	660 A 80 E	1,000 A, E	1,750 A 360 E	10,000 A 100 N	1,400 A 255 I*	2,500 A 350 E	1,000 A 200 I 400 N

continued

Table II: Population Estimates and Breeding Information from Munter (1915), Wetmore (1923), and the Pacific Ocean Biological Survey Program for Lisianski Island.

(* indicates actual count, A- adult, I- immature, N- nestling, E- nests with egg or eggs). *For birds that were banded*

White is apparently using population estimates from 1965. See report on birds.

July 1965
1965
Rebels

	March 1915	May 1923	March 1963	March 1964	August 1964	September 1964	March 1965	July 1965
Golden Plover		15 A	400 A	600 A	30 A	75 A	2,000 A	
Ruddy Turnstone	12 A*	4 A*	300 A	1,000 A	200 A	1,000 A	2,000 A	200 A
Bristle-thighed Curlew	1 A*	4 A*	200 A	100 A	100 A	30 A	150 A	50 A
Wandering Tattler		5 A*	12 A	10 A	10A		24 A	
Sanderling			20 A	20 A		2 A*	5 A	
Sooty Tern	1,000 A	500 A 250 E		75,000 A	160,000 A 40,000 N	4,000 I	3,500 A	250,000 A 50,000 I 50,000 N
Gray-backed Tern	500 A 1 E*	500 A E, N	200 A	500 A	3 A* 2 I*		2,500 A 1,100 E 1 N*	300 A 100 N
Noddy Tern	300 A	1,000 A few E	200 A	25 A	1,600 A 400 I	2,700 A Some I	500 A E, N	1,000 A 300 N
Hawaiian Noddy Tern	1,000 A E, N	1,000 A	300 A	1,000 A 100 N 100 E	400 A	100 A	2,500 A 50 N 300 E	100 A 30 N
Fairy Tern		2 A*	50 A	50 A 5 N* 7 E*	50 A	25 A	100 A 15 E	50 A 15 N

Table III: Birds banded by the POBSP on Lisianski Island.

Blackfooted Albatross, imm.	2
Laysan Albatross, imm.	2384
Wedge-tailed Shearwater	501
Christmas Island Shearwater	7
Bonin Island Petrel	3500
Red-tailed Tropicbird, adult	37
imm.	65
Blue-faced Booby, adult	560
imm.	79
Brown Booby, adult	8
imm.	4
Red-footed Booby	10
Great Frigatebird, adult	75
imm.	43
Ruddy Turnstone	28
Bristle-thighed Curlew	6
Sooty Tern, adult	6800
imm.	7000
Gray-backed Tern	374
Hawaiian Noddy Tern, imm.	100
Fairy Tern	10
Total	<u>21593</u>

Table IV: Species recorded for Lisianski Island and their probable status.

Black-footed Albatross	<i>Diomedea nigripes</i>	Breeds annually
Laysan Albatross	<i>Diomedea immutabilis</i>	Breeds annually
Wedge-tailed Shearwater	<i>Puffinus pacificus</i>	Breeds annually
Christmas Island Shearwater	<i>Puffinus nativitatus</i>	Breeds annually
Bonin Island Petrel	<i>Pterodroma hypoleuca</i>	Breeds annually
Bulwer's Petrel	<i>Bulweria bulwerii</i>	Rare visitor ¹
Sooty Storm Petrel	<i>Oceanodroma markhami</i>	Rare visitor ?
Red-tailed Tropicbird	<i>Phaethon rubricauda</i>	Breeds annually
Blue-faced Booby	<i>Sula dactylatra</i>	Breeds annually ²
Brown Booby	<i>Sula leucogaster</i>	Breeds annually ²
Red-footed Booby	<i>Sula sula</i>	Breeds annually ²
Great Frigatebird	<i>Fregata minor</i>	Breeds annually ²
Laysan Teal	<i>Anas laysanensis</i>	Hypothetical ³
Osprey	<i>Pandion haliaetus</i>	Hypothetical accidental
Peregrine Falcon	<i>Falco peregrinus</i>	Accidental
Laysan Rail	<i>Porzana palmeri</i>	Hypothetical ⁴
Golden Plover	<i>Pluvialis dominica</i>	Regular migrant
Black-bellied Plover	<i>Squaterola squaterola</i>	Rare migrant
Ruddy Turnstone	<i>Arenaria interpres</i>	Regular migrant
Bristle-thighed Curlew	<i>Numenius tahitiensis</i>	Regular migrant
Wandering Tattler	<i>Heteroscelus incanum</i>	Regular migrant ⁵
Bar-tailed Godwit	<i>Limosa lapponica</i>	Accidental
Sanderling	<i>Crocethia alba</i>	Regular migrant ⁵

Table IV continued

Glaucous-winged Gull	<i>Larus glaucescens</i>	Accidental ⁶
Herring Gull	<i>Larus a. vegae</i>	Accidental
Sooty Tern	<i>Sterna fuscata</i>	Breeds annually
Gray-backed Tern	<i>Sterna lunata</i>	Breeds annually
Noddy Tern	<i>Anous stolidus</i>	Breeds annually ²
Hawaiian Noddy Tern	<i>Anous minutus</i>	Breeds annually ²
Fairy Tern	<i>Gygis alba</i>	Breeds annually ²

1) Breeding, ?; 2) Resident, ?; 3) reported as resident in 19th Century; 4) reported as resident in 19th Century, reintroduced in 1913, but now extinct; 5) in small numbers; 6) possibly rare visitor.

gives a breakdown by age and species of the 21,593 birds banded on Lisianski by the POBSP. Band returns of significance and interesting movements are discussed in the following sections by species.

A summary of the species recorded for the island and their probable status is given in Table IV.

Black-footed Albatross (Diomedea nigripes)

Current Status: Breeds annually.

Prior Records: The species was first reported from Lisianski by Herr C. Isenbeck, who visited the island in late March 1828. The observations of Isenbeck were reported by Kittlitz (1834) and the latter was translated by Rothschild (1893-1900). The third-hand data describes an albatross "chestnut-brown, with black bill and feet," as common on Lisianski, "living on the flat ground." Many "young ones, which were covered with grey down" were found.

Henry Palmer and George Munro next observed the species while collecting for Rothschild on Lisianski in late June and early July 1891 (Rothschild, op. cit. and Munro, op. cit.). They found the birds nesting, with large chicks, all along the upper margin of the beaches (Munro, op. cit.).

In March 1913 the species was more numerous than the Laysan Albatross (Bailey, 1952). Munter (1915) found the species fairly numerous in March 1915, but not so numerous as the Laysan. The young were well developed but still in pin feathers. Nests were found scattered all over the island, but more concentrated along the shores. Very few eggs were seen and no dead young or adults were noted. He estimated their number at 8,000 birds. Wetmore (unpub. notes, 1923) found about 1000 pairs on the island in May 1923. Some young were nearly fledged, while others had only the breast plumage

complete. Richardson (1957) visited the island in late March 1954, and his photograph shows half grown nestlings. He estimated the island population at 1000 birds (pers. comm.). Aerial counts were made by personnel of the Bureau of Sport Fisheries and Wildlife between December 1956 and June 1957 and the population was estimated at 6,500 (Kenyon, Rice, Robbins, and Aldrich, 1958). Rice and Kenyon (1962) counted 3,665 birds and allowed for 25 percent unemployed birds to arrive at an estimate of 2,700 pairs for the breeding seasons of 1956-57 and 1957-58. In March 1961 the species was found nesting on the beaches and in small open sandy areas (Woodside and Kramer, 1961). The nestlings were one-third grown at this time.

Population: Adults have been found on POBSP visits in March of 1963, 1964 and 1965, but not in August or September 1964 or July 1965. Several thousand were present in March 1963, and 3,500 in March 1965, but an estimated 10000 were present in March 1964. In March 1964 there were an estimated 1750 nestlings on the island, and in March 1965, 1300 were found. By July 1965 only 200 nestlings remained.

Reproduction: The species nests in small numbers along the beaches and in clearings in the peripheral vegetation of the island. Egg-laying begins in mid-November and most hatching occurs in January and early February on Kure Atoll, 300 miles to the northwest. There is no reason to suspect that these dates should not also be valid for Lisianski.

Large nestlings were found on Lisianski in late June 1891 (Munro, op. cit.). Munter (op. cit.) found well grown young, but still in pin feathers, fairly numerous on Lisianski in March 1915. Very few eggs were found. Nestlings, ranging from just beginning the contour plumage to nearly-fledged, were found there in May 1923 (Wetmore, unpub. notes, 1923). A photograph by

Richardson (op. cit.) shows half grown nestlings in late March 1954. About 2,700 pairs were present during the breeding seasons of 1956-57 and 1957-58 (Rice and Kenyon, 1962).

The POBSP has found nestlings one-quarter to one-third grown in March of 1963, 64 and 65. About 1750 were present in March 1964, and 1300 in March 1965. By July 1965 only 200 large nestlings remained.

Movement: An adult banded at Kure Atoll in early January 1964 was recaptured on Lisianski in March 1965.

Other Specimens: USNM 300828, ♂, 17 May 1923; USNM 300829, ♂, 18 May 1923.

Laysan Albatross (Diomedea immutabilis)

Current Status: Breeds annually.

Prior Records: This albatross was first reported from Lisianski by Herr C. Isenbeck in late March or early April 1828, and reported in the literature in the same manner as described for the previous species. The birds were "plentiful," "living on the flat ground" (Kittlitz, op. cit.).

Laysans were next reported for the island when Palmer and Munro collected there for Rothschild in late June 1891 (Rothschild, op. cit.). They found them nesting over the whole island, but not as thick as on Laysan Island, and collected two partial albino nestlings (Munro, 1942).

In March 1913 Bailey (1952) noted only that this species was not as numerous as D. nigripes. Munter (op. cit.) found birds nesting on all parts of the island in March 1915. Young birds, still in pin feathers, were fairly numerous. Very few eggs were found, and no dead young or adults were noted. About 10,000 birds were present. Wetmore (unpub. notes, 1923) estimated that there were not more than 800 pairs on the island in May 1923. Nestlings

were present, and their breast plumage was just coming in. The island was visited by Richardson (1957) in late March 1954, and a photograph in his paper shows half-grown nestlings. He estimated the island population at 3000 birds (pers. comm.). Personnel of the Bureau of Sport Fisheries and Wildlife made aerial surveys of the island between December 1956 and June 1957 and estimated that 68,000 birds were present (Kenyon, Rice, Robbins, and Aldrich, 1958).

Rice and Kenyon (1962) estimated that 30,000 pairs were present in the 1956-57 and 1957-58 breeding seasons. However, they state that they could not accurately count Lisianski from the air due to the dense vegetation. Their estimate for Lisianski was derived by comparing the aerial photographs with some from Eastern Island, Midway Atoll, where nesting density was known from ground counts. The POBSP has surveyed both Eastern and Lisianski from the ground, and it has been our experience that very few pairs nest throughout the vegetation on the latter island, but do on the former. Therefore, it seems likely that the Laysan Albatross population of Lisianski does not reach the magnitude indicated by Rice and Kenyon.

Woodside and Kramer (1961) visited the island in March 1961 and found most of the nests on the upper beach and in clearings, with only marginal nesting in the dense grass of the interior. They found the nestlings about one-third grown at this time.

Population: Adults have been found on POBSP visits in March of 1963, 64 and 65, but not in August or September 1964 or July 1965. Many thousand adults were present in March 1963, but the number of nestlings was not estimated. The adult population was placed at 8500 in March 1964 and 8000 in March 1965, while the number of nestlings was placed at 2600 on the former date and 2750

on the latter. In August 1964 30 immatures remained on the island, while in July 1965 2000 nestlings were still present.

Reproduction: The species nests primarily along the perimeter of the vegetated portions of the island and in some clearings. But large portions of the interior, even where the vegetation is sparse, have not been utilized in the years in which POBSP visits have been made. Egg-laying begins in late-November and is completed by the end of December, and most chicks hatch in February on Kure Atoll, 300 miles to the northwest. There is no reason to suspect that these dates should not also be valid for Lisianski.

Large nestlings were found in late June 1891 (Munro, 1942). Munter (op. cit.) found the young well grown, but still in their pin feathers, in March 1915. Only a few eggs were noted. Wetmore (unpub. notes, 1923) found nestlings with the breast plumage just coming in in May 1923. A photograph taken by Richardson (1957) in late March 1954 shows half-grown nestlings. About 30,000 pairs were estimated to have been present in the 1956-57 and 1957-58 breeding seasons (Rice and Kenyon, 1962), but this figure was questioned in the prior records section.

Nestlings were found by the POBSP on a brief visit in early March 1963, but no estimate of numbers was made. About 2600 were present in March 1964, but only 30 immatures remained the following August, and the species was absent in September 1964. There were 2750 nestlings present in March 1965, and 2000 were still present in July of that year. Many of the smaller down-covered chicks were emaciated and probably did not survive. The larger birds were already practicing flying. They were found generally distributed over the island, but congregated in open areas and on the beach in the daytime and moved into the Scaevola at night.

Movement: Dr. H. I. Fisher of Southern Illinois University, visited Lisianski on 18 July 1962. At this time 1697 nestling Laysan Albatross from Sand Island, Midway Atoll, were transported to Lisianski in an experiment designed to test whether site attachment could be altered in young birds. All the young were banded and marked with red plastic bands as well. No live birds have as yet been found back on Lisianski from this experimental group.

Other Specimens: AMNH 526869, nestling, 3 July 1891; USNM 300849, ♀, 17 May 1923; USNM 300850, ♂, 19 May 1923; USNM 300851, ♂, 17 May 1923.

POBSP Specimens: USNM 495735, ♀, ovary 20 x 11 mm., 17 July 1965.

Albatross (hybrid?) (D. immutabilis x nigripes)

Current Status: An adult was collected in March 1963 which is either a hybrid or a mutant immutabilis.

The specimen has the body and bill configuration of immutabilis, and also the black shading before and over the eye which is characteristic of this species. But the head, neck and breast are steel gray where the typical immutabilis is white in these areas. The mantle is typical immutabilis color, though somewhat mottled in the down feathers. The feet and legs are grayish-black, whereas the typical immutabilis color is grayish-pink or flesh color.

POBSP Specimens: USNM 493918, ♂, te. 15 x 7 mm., 11 March 1963; USNM 497919, trunk skeleton of USNM 493918.

Wedge-tailed Shearwater (Puffinus pacificus)

Current Status: Breeds annually.

Prior Records: The species was first found on Lisianski by Isenbeck in late March 1828 and reported by Kittlitz (op. cit.) and Rothschild (op. cit.).

It was seen sitting in pairs, but no eggs were found. When Palmer and Munro visited the island in late June 1891 they found burrows all over the island, mostly with eggs, ^{no ref is to Bonin} but a few young (Munro, op. cit.). Wedgetails were also numerous at sea before they reached the island. Munter (op. cit.) noted that the species was "very common and found everywhere on the island" in March 1915. They were generally found in pairs and sometimes in small colonies. "Just before sundown a great many of them were noticed on the wing over the water." About 15,000 birds were present on the island, but no eggs were found.

In May 1923 Wetmore (unpub. notes, 1923) noted that this was the most abundant species. He found them scattered in pairs or in small groups everywhere on the island. Copulation was observed frequently, but no eggs were found. Birds were seen above ground during the day, and there was a great amount of activity at dusk. About 25,000 birds were present.

Richardson (pers. comm.) saw 10 to 15 birds in March 1954. Woodside and Kramer (1961) noted that the interior bunchgrass areas were honeycombed with burrows of this species and the Bonin Island Petrel (Pterodroma hypoleuca) in March 1961.

Population: The species has been found on each POBSP visit to the island. Only one adult was found in early March 1963, about two dozen, with some courting pairs, were found in March 1964, and 150 were present in mid-March 1965. In August 1964 there were an estimated 40,000 adults and 10,000 immatures present. Birds were distributed over most of the island in areas of bunchgrass and Boerhavia, sharing this plant association with Bonin Island Petrels (Pterodroma hypoleuca) and Sooty Terns (Sterna fuscata) in some places.

Two large clubs were observed, one at each end of the island, in bare sand areas near the beach. The following month a total population of 30,000 birds, including many immatures, was estimated. In July 1965 there were an estimated 45,000 birds on the island.

Reproduction: Nest burrows have been found throughout the vegetated interior of the island, but are especially numerous in bunchgrass. Nests are occasionally constructed above ground beneath the Scaevola or at the base of a bunchgrass clump. Burrows seem to be generally about two feet deep. The bunchgrass areas most heavily utilized by this species are also the preferred nesting locality for the Sooty Tern on the island.

Adults return to the Leewards in March, but egg-laying does not begin until early June on Kure Atoll, 300 miles to the northwest. Hatching occurs primarily in August, and immatures are present until November, on Kure. The breeding schedule is probably very similar on Lisianski.

Courting pairs have been observed on Lisianski in March 1828 (Rothschild, 1893-1900), May 1923 (Wetmore, unpub. notes, 1923), and March 1964 and 1965. Munro (1942) found eggs and a few young in late June 1891. Munter (op. cit.) found the species numerous in March 1915, but did not find any eggs. No nestlings were found, but most burrows contained eggs, in mid-July 1965. No eggs were found in August and September 1964, but many nestlings and immatures were present.

Movement: An adult banded on Lisianski in August 1964 was recaptured on Laysan, 130 miles to the east, in August 1965.

Other Specimens: USNM 300727, ♀, 16 May 1923; USNM 300728, ♀, 16 May 1923; USNM 300729, ♀, 16 May 1923; USNM 300730, ♂, 17 May 1923; USNM 300731, ?, 19 May 1923; USNM 300732, ♂, 19 May 1923; USNM 300733, ♀, 16 May 1923; USNM 300735, ♀, 19 May 1923.

POBSP Specimens: USNM 492959, ♀, ovary 12 mm., 12 March 1963; USNM 495631, ♀, ovary 9 x 5 mm., largest ovum 1.5 mm., 16 July 1965; USNM 495632, ♀, ovary 10 x 4 mm., largest ovum 1.5 mm., 16 July 1965.

Christmas Island Shearwater (Puffinus nativitatis)

Current Status: Breeds annually.

Prior Records: The species was not found on Lisianski by Isenbeck in 1828 (Kittlitz, op. cit.), but was recorded by Palmer and Munro in June 1891 (Munro, op. cit.). They found it less numerous than on Laysan, and with eggs nearly hatched. ^{? where P.O.} Munter (op. cit.) found the species very common on Lisianski in March 1915. About 10,000 birds were scattered over the island, usually in association with Wedge-tailed Shearwaters. No eggs were found. Wetmore (unpub. notes, 1923) estimated about 300 pairs to be present in May 1923. Eggs were found.

Population: Except for March 1964, the species has been noted on each POBSP visit. Only a small number of adults were found in March 1963, but an estimated 750 were present in March 1965. The population was placed at 400 in July 1965. A nestling was found in August, and three adults in September, 1964.

Reproduction: Nearly hatched eggs were found in late June 1891 (Munro, op. cit.). Munter (op. cit.) did not find any eggs on Lisianski in March 1915. Eggs were found in May 1923 (Wetmore, unpub. notes, 1923). A large downy nestling was found under Scaevola at the north side of the island in August 1964. Though several pairs were handled in March 1965, no eggs were found, and the birds handled did not have brood patches.

Eggs have been found in late April and May, downy nestlings in June and July, and immatures in September and October, on Kure Atoll, 300 miles to the northwest. But the number of observations on this atoll are also

insufficient to be certain of the breeding season.

Other Specimens: USNM 300697, ♂, 17 May 1923; USNM 300698, ♀, 17 May 1923.

POBSP Specimens: USNM 492967, ♂, 12 March 1963; USNM 494122, ♀, ovary 5 mm., 310 gms., 13 March 1965; USNM 494123, ♂, te. 15 x 10 mm., 13 March 1965.

Bonin Island Petrel (Pterodroma hypoleuca)

Current Status: Breeds annually.

Prior Records: This species is not mentioned by Kittlitz (op. cit.) in his account of the visit to Lisianski by Isenbeck in 1828. The only petrel described in this account is the Wedge-tailed Shearwater (Puffinus pacificus). Palmer and Munro found burrows all over the island in late June 1891. (Munro, op. cit.). Only a few fledged young were left, and they felt that the breeding season was over.

Wetmore (unpub. notes, 1923) saw a few in May 1923, and estimated about 50 birds to be present on the island. Those he collected were sexually inactive. Their burrows were found only in the vegetated area of the island.

Population: About 500 birds were noted in the air by Richardson (pers. comm.) in March 1954. Adults have been noted on each POBSP visit to the island. Many thousands were present in March 1963 when the species were nesting. In March 1964 the population was estimated at 100,000, while in March 1965 it was placed at one million. Birds returned to the island in "great clouds" (W.O.W., II) at dusk, and were so numerous in the air that they were frequently observed to brush together in flight (ibid.). On this latter trip a major portion of the two nights spent ashore was devoted to banding this species, and the population estimate is based on the number of birds per acre in the area covered by banding operations. As the species has been found uniformly distributed over the island it is likely that this

very high figure is actually the most accurate.

In August 1964 the population was estimated at 15,000 but the following month only three birds were seen. During July 1965 an estimated 200 birds were reported.

Reproduction: The species has nesting burrows throughout the vegetated portion of the island. Burrow density is greatest in the large bunchgrass areas, and lowest under the rim of Scaevola at the perimeter of the island. In March 1965 eggs and small nestlings were found over much of the island. Eggs were frequently found above ground in the bunchgrass and morning-glory habitat. In August 1964 adults returned to the island in greatest numbers in the half hour before and after sunset. Courtship behavior was not observed; all birds seen were sitting alone, though a good deal of calling was heard all night. In July 1965 only a few adults were observed, usually sitting at burrow entrances.

Egg-laying occurs primarily in January on Kure Atoll, 300 miles northwest, and nestlings have been found in March, April and July at Pearl and Hermes Reef, 150 miles northwest.

Other Specimens: AMNH 528329, ?, 3 July 1891; USNM 300662, ♀, 17 May 1923; USNM 300663, ♂, 17 May 1923; USNM 300664, ♀, 17 May 1923; USNM 300665, ♂, 17 May 1923.

POBSP Specimens: USNM 494125, ♂, te. 4 x 4 mm., 4 x 3 mm., 152.1 gms., 13 March 1965; USNM 494126, ♀, ovary 10 x 6 mm., largest ovum 1.5 mm., 165.6 gms., 13 March 1965; USNM 497951, ♂, 14 February 1963, skeleton.

Bulwer's Petrel (Bulweria bulwerii)

Current Status: Rare visitor, breeding?

Prior Records: Munro (1941) found adults incubating eggs on Lisianski in late June 1891. Most nests were under bunchgrass clumps. Large numbers

came in to the island at night. Wetmore (unpub. notes, 1923) noted that it was fairly common at dusk in May 1923, and collected several specimens.

Population: The species has only been noted once by the POBSP. A few were seen flying over the island at dusk in mid-July 1965, but none were found on the ground. On this same trip nestlings were found on Laysan Island, 130 miles to the east.

Other Specimens: USNM 300801, ♀, 17 May 1923; USNM 300802, ♀, 17 May 1923; USNM 300803, ♀, 17 May 1923; USNM 300804, ♀, 17 May 1923; USNM 300805, ♀, 17 May 1923.

Sooty Storm Petrel (Oceanodroma markhami)

Current Status: The POBSP has a questionable sight record of one bird from March 1963 (W.O.W., II).

Red-tailed Tropicbird (Phaethon rubricauda)

Current Status: Breeds annually.

Prior Records: The species was not recorded by Isenbeck in 1828 (Kittlitz, op. cit.), nor by Palmer and Munro in 1891 (Rothschild, op. cit.). Munter (op. cit.) did not find this species on Lisianski in March 1915. Wetmore (unpub. notes, 1923) saw only two birds in May 1923, and found no nests. Richardson (pers. comm.) found 10 birds in March 1954. Woodside and Kramer (op. cit.) saw many flying over the west side of the island, and several on the ground under bushes, in March 1961. They found no nests.

Population: A few adults were found in March 1963, but no nests were noted. An estimated 125 adults were present in March 1964. In August 1964 the adult population was placed at 300, ten eggs were found, and an estimated 140 nestlings were present. The following month 12 adults and five immatures

were counted, and the island population was placed at 50 birds. In March 1965 the survey found 25 adults on the island. The following July the island population was estimated at 1000 adults and 200 nestlings.

Reproduction: One egg was found in March 1965, but none were found in March 1961 (Woodside and Kramer, op. cit.), March 1963, or March 1964. Ten eggs were found in August 1964, when an estimated 140 nestlings of several age groups were found. Most were found primarily

under the Scaevola growth at the perimeter of the island. The following month only five immatures were found. In July 1965 there were approximately 200 nestlings present, ranging in age from hatchlings to nearly fledged. Most eggs found were in an advanced stage of incubation.

Egg-laying begins in late February and March on Kure Atoll, 300 miles to the northwest. Hatching begins in March and continues through July on Kure, and a few immatures remain on the atoll through November. The cycle on Lisianski is probably similar.

Other Specimens: USNM 191499, no sex or date; USNM 300983, ♂, 17 May 1923.

Blue-faced Booby (Sula dactylatra)

Current Status: Probably resident, breeding annually.

Prior Records: Isenbeck found the species rather common on Lisianski in March 1828 (Kittlitz, op. cit.). He found them nesting in open scrapes on the beach, with eggs in the early stages of incubation. Palmer and Munro found the species with large nestlings in late June 1891 (Munro, op. cit.). Many were seen by Bailey (1956) in March 1913. Munter (op. cit.) found this booby in fairly large numbers on Lisianski in March 1915. Some were nesting near the frigate rookeries, but most nested along the beaches just above the

high water mark. "Eggs or young birds in various stages of development were found in the nests." Three or four young nearly ready to fly were noted. "One nest contained three eggs - an oddity, no doubt." "These birds seem to lose one of their offspring, as invariably we have seen but one young bird, or a freshly hatched bird and one egg, in the same nest."

In May 1923 Wetmore (unpub. notes, 1923) found about 100 pairs nesting on the island, mainly near the one plot of grass at the northern end of the island. Immatures were present, as well as nestlings of several age groups. In March 1961 the species was found nesting at the edge of the vegetation above the beach all around the island (Woodside and Kramer, op. cit.). An estimated 400 birds were present in March 1954 (Richardson, pers. comm.).

Population: The resident population of Lisianski seems to be between 300 and 500 adults. In March 1963 the population was placed at 500 adults, with nestlings and eggs. The following year the estimate was 575 adults, with nestlings and eggs. In August 1964 the estimate was again 500 adults with 100 immatures and a few nestlings and eggs. The population was scattered along the beach, but two large clubs, mainly of adults, were found in clearings just off the beach, one at the north, and one at the south end of the island. Many of the immatures were still being fed by adult birds. However, in September 1964 the population was placed at 250 adults and immatures. Adults outnumbered immatures about two to one. In March 1965 the Survey estimated that 875 adults were present at night, and breeding pairs had nestlings and eggs. The following July there were an estimated 300 adults and 100 nestlings on the island.

Reproduction: The species was nesting with eggs in early stages of incubation in March 1828 (Isenbeck in Kittlitz, op. cit.). Large nestlings

were found in late June 1891 (Munro, op. cit.). Munter (op. cit.) found eggs to nearly fledged young in nests on the bare sand along the beaches of Lisianski in March 1915. A few also nested near the frigate colonies. Immatures and nestlings of several age groups were found in May 1923 (Wetmore, unpub. notes, 1923). Nests found in March 1963 had eggs and small nestlings. In March 1964 over 100 nests had eggs and about 100 had small nestlings. In August 1964 one nest with eggs and one with a nestling were found. About 100 immatures were noted on the beaches. The following month 54 immatures were counted. In March 1965 about 100 nests were found. Two had large nestlings, several had very young nestlings and most had eggs.

On Kure Atoll, 300 miles to the northwest, the breeding cycle normally extends from late February to late November. Most egg-laying occurs in March, and hatching occurs in late March and April. Many young fledge by late July, but are still fed by adults through September. Immatures usually leave the atoll by mid-December. These data probably apply to Lisianski as well.

Movement: An immature banded on Lisianski in August 1964 was recaptured on Sand Island, Johnston Atoll, about 650 miles southeast, in March 1965. An adult banded on Trig Island, French Frigate Shoals, in June 1963, was recaptured on Lisianski in March 1965. These islands are about 500 miles apart. An adult banded on Lisianski in March 1964 was recaptured on Laysan, 120 miles to the east, in August 1965.

Other Specimens: USNM 189415, ♂, 20 May 1902; USNM 300942, ♀, 17 May 1923; USNM 300943, ♂, 18 May 1923; USNM 300944, ♂, 18 May 1923.

Brown Booby (Sula leucogaster)

Current Status: Probably resident, breeding annually in small numbers.

Prior Records: The species was first noted on Lisianski by Isenbeck in 1828 (Kittlitz, op. cit.). Several were collected by Palmer in late June 1891 (Rothschild, op. cit.), including two young. He found this species the scarcest booby in the Leewards. No eggs were found on Lisianski. Bailey (1956) saw about a dozen on the island in March 1913. Munter (op. cit.) found the species nesting near the frigatebirds and scattered along the shores with the Blue-faced Booby, but not nearly as numerous, in March 1915. They nested on the ground in a slight depression with a few sticks and one or two feathers. He found eggs or young in the nests, and several of the young were well developed. Two lime white eggs were found in the nests, but as with the Blue-faced Booby he noted that only one young was raised. He estimated that 75 to 100 birds were present on the island. Wetmore (unpub. notes, 1923) found about 40 pairs on the island in May 1923. He found most nests in the grass patch at the northern end of the island, but some were on the bare ground at the eastern side. Hatchlings and young nestlings were found, but most nests contained eggs. An immature was collected. Richardson (pers. comm.) saw only two birds in March 1954. In March 1961 several nests without eggs were found in the interior (Woodside and Kramer, op. cit.).

Population: The resident population of the island is probably between 25 and 50 adults. About 30 adults were present in March 1963, and a few immatures were noted. Only 17 birds were present in March 1964. In August of that year about 50 adults utilized the island. A few were seen along the rocky portion of the eastern shore in the day time, but most were found in the

morning-glory patches on the northwest side at night. The following month the island population was placed at 25, and 10 adults and one immature were counted. In March 1965 about 25 adults were found on the island. One nest with eggs was found in the interior at the western side. The following July six pairs with nearly fledged young were found. The island population was estimated at 100 birds.

Reproduction: Young were found by Palmer in late June 1891 (Rothschild, op. cit.). Munter (op. cit.) found eggs or young birds in nests along the beaches and near the frigate colonies in March 1915. Several of the young were well developed. Wetmore (unpub. notes, 1923) found nests with eggs to young nestlings in May 1923, and collected an immature. Nests without eggs were found by Woodside and Kramer (op. cit.) in March 1961.

Only one nest with eggs has been found in recent years, in March 1965. Six large nestlings were found in July 1965. Immatures were noted in March 1963, and September 1964.

The species breeds from early April to mid-December, on Kure Atoll, 300 miles to the northwest. Egg-laying occurs in April, May, and early June on Kure, and hatching in late June, July, and August. The season is less sharply delineated on Kure than that of the other two species of Sula. Flying immatures remain about the atoll until early December. The cycle is probably similar on Lisianski.

Other Specimens: AMNH 729471, ♂, 30 June 1891; AMNH 729472, ♂, 30 June 1891; AMNH 729473, ♂, 30 June 1891; AMNH 729474, ♂, 1 July 1891; AMNH 729475, ♂, 2 July 1891; AMNH 729476, ♀, 3 July 1891; AMNH 729477, ♀, 3 July 1891; AMNH 729478, ♀, 30 June 1891; AMNH 729479, ♀, 1 July 1891; AMNH 729480, ♀, 3 July 1891; AMNH 729481, ?, 1 July 1891; USNM 240994, ♀, 12 March 1913; USNM

300873, ♀, 19 May 1923; USNM 300874, ♂, 19 May 1923; USNM 300875, ♂, immature, 16 May 1923.

Red-footed Booby (Sula sula)

Current Status: Probably resident, breeds annually.

Prior Records: The species was probably recorded, as something else, by Isenbeck in 1828 (Kittlitz, op. cit.). As illogical as it may seem, a bird listed as Larus sp., perhaps argentatus, "seen in great numbers flying around Gardner Island, and later on Mollere [= Laysan] and Lisianski too" is probably this booby. This conclusion is reached by a process of elimination among Isenbeck's species accounts.

This booby is definitely recorded from Lisianski in late June 1891 (Rothschild, 1893-1900). Henry Palmer recorded in his notes for 30 June 1891: "The small Gannets (Sula piscator [= sula]) are sitting on their nests, which are built on some small scrub." Several nests of this species were found near the Japanese poachers shacks by Munter (op. cit.) in March 1915. Young birds or eggs were found in the nests, but only about ten birds were noted for the island. In May 1923 Wetmore (unpub. notes, 1923) found about 25 adults roosting in the grass patch at the northern end of the island at night, or on the remains of the Japanese feather poachers camp. He found two nests with eggs; the single egg had been laid in the top of a clump of bunchgrass. The total island population was placed at 40 birds. About 50 birds were present in March 1954 (Richardson, pers. comm.). In March 1961 Woodside and Kramer (op. cit.) found birds nesting in the Scaevola, but "comparatively rare."

Population: The species has been found on each POBSP visit to the island. As the island was not thoroughly surveyed in March 1963 the estimate of 50 adults is probably too low. In March 1964 about 450 adults were present.

with about 125 eggs. The report for August 1964 lists 300 adults roosting in the Scaevola, ironwoods, and palm trees, but further states that no evidence of nesting was found. This is certainly in error, for the following month 298 adults, 103 immatures, and 17 nestlings were counted, and the island population placed at 500 birds. In March 1965 an estimated 1000 birds roosted over much of the Scaevola, and in the ironwoods, but only a few eggs were found. The following July an estimated 500 adults and 200 nestlings were found, with nests scattered through the Scaevola of the interior.

Reproduction: Palmer (Rothschild, op. cit.) noted birds nesting in late June 1891. Munter (op. cit.) found a few nests with eggs or young birds in March 1915. Wetmore (unpub. notes, 1923) found two eggs in May 1923, and Woodside and Kramer (op. cit.) reported nesting in March 1961.

The species was nesting, with eggs, in March 1963, and about 125 eggs were present in March 1964. Only a few eggs were found in March 1965. In September 1964 103 immatures and 17 nestlings were counted. An estimated 200 nestlings, ranging from half grown to nearly fledged, were found in July 1965.

Egg laying begins in March and probably continues into May on Kure Atoll, 300 miles to the northwest. Most eggs hatch in June and early July on Kure and the young are flying by early September. The breeding cycle is probably similar on Lisianski.

Movement: An adult banded at French Frigate Shoals, 500 miles eastward in the Leeward Chain, in June 1963, was recaptured on Lisianski in March 1964.

Other Specimens: USNM 300909, ♂, 19 May 1923; USNM 300910, ♂, 19 May 1923.

Great Frigatebird (Fregata minor)

Current Status: Probably resident, breeds annually.

Prior Records: Specimens were collected on Lisianski by Isenbeck in 1828 where the species was numerous and many eggs were found in loosely constructed nests of twigs placed on the bushes (Kittlitz, op. cit.). Palmer and Munro found "large numbers ... their nests on the scrub around the lake," in late June 1891 (Rothschild, op. cit.). On this trip Munro (op. cit.) reports that he saw an adult land in very calm water and take off again without any trouble. Bailey (1954) found this the most numerous nesting species when he visited Lisianski in March 1913.

Munter (op. cit.) found three separate colonies on Lisianski in March 1915. He noted that they nested where ever there was sufficient shrubby vegetation. A colony of about 1000 birds was found at the north end of the island, a second of about 1200 birds on the northeast shore, and a third near the shacks in the central part of the island contained about 800 birds. Other birds roosted on dead or dying bushes along the beach. The total number on the island "would not exceed 3500."

In May 1923 Wetmore (unpub. notes, 1923) found about 80 pairs nesting with eggs, and another 500 or so roosting on the island. The eggs were laid in the crowns of the few remaining clumps of bunchgrass.

An estimated 400 birds were found by Richardson (pers. comm.) in March 1954.

Population: Large numbers of roosting birds have been found on every POBSP visit to the island. An estimated 1000 adults were found in March 1963, and egg-laying had begun. In March 1964 an estimated 1750 adults had about 360 eggs. In August 1964 the survey team reported great numbers aloft over

the island all day, increasing in late afternoon. Nesting was confined chiefly to Scaevola growth on the southern half of the island, and about 100 nestlings were one to two thirds grown. An estimated 10,000 adults and flying immatures were present. The following month 235 immatures were counted, and the total population was estimated at 1600. In March 1965 an estimated 2500 adults were present with about 350 nests with eggs. The following July 1000 adults, 200 immatures, and 400 nestlings were reported. The latter ranged from newly hatched to nearly fledged.

Reproduction: Eggs were found in late March 1828 (Kittlitz, op. cit.) and late June 1891 (Rothschild, op. cit.). The species was nesting in March 1913 (Bailey, 1956), and March 1915 (Munter, op. cit.). About 80 pairs had eggs in May 1923 (Wetmore, unpub. notes, 1923).

Eggs were present in March 1963, but their number was not estimated. An estimated 1750 adults had about 360 eggs in March 1964. In August 1964 about 100 nestlings were noted, and the following month 235 immatures were counted. As this species remains in immature plumage for more than one season these data do not necessarily infer that the August nestling count was too low. However, when compared to the egg count of March it is possible that these immatures were mostly a product of the year's breeding. In March 1965 an estimated 2500 adults had about 350 eggs, and the following July about 200 immatures and 400 nestlings were reported.

Laysan Teal (Anas laysanensis)

Current Status: Extinct.

"A species of duck, with no conspicuous plumage," was found "living in small flocks on Moller [Laysan] and Lisiansky, but not breeding," by Herr C. Isenbeck in late March 1828 (Kittlitz, op. cit.). ^{Ducks were} ~~It was~~ not Tame flocks of ducks were reported for the island by Pell (1844) in April 1844.

found by Palmer and Munro in June 1891 (Rothschild, op. cit.), and have never been subsequently seen, though a sizable population still survives on Laysan Island. The presence of a dry lake bed on Lisianski lends evidence to Isenbeck's report, since the lake would have created habitat similar to that presently utilized by the teal on Laysan (Warner, 1963).

Osprey (Pandion haliaetus)

Current Status: Hypothetical accidental.

An "eagle-like bird" was observed by J. E. King on Lisianski in June 1950. He decided later that it was probably an osprey. (King, 1956).

Peregrine Falcon (Falco peregrinus)

Current Status: Accidental.

An unidentified hawk was observed pursuing Bonin Island Petrels about a mile off shore as the POBSP approached Lisianski on 12 March 1965. The following day a hawk roost with the remains of 60 to 70 shore bird kills, three Gray-back Tern kills, and several casts beneath it, was found in an ironwood tree in the interior of the island. A hawk, identified as this species, was independently seen by several members of the survey team on 13 and 14 March 1965.

It is worthwhile to note that a Peregrine Falcon was collected by the POBSP on Kure Atoll, 300 miles to the northwest, on 7 March 1965.

Range: Nearly cosmopolitan, ranging from Alaska to Greenland south through the Americas to Tierra del Fuego and the Falkland Islands; and the Komandorskie Islands south through Europe, Africa and Asia to Malaysia and the Philippines, the East Indies, New Guinea, Australia and Tasmania; in the Southwest Pacific to Palau, the New Hebrides, Fiji, and the Loyalty islands, but absent from islands of the eastern Pacific and New Zealand. (AOU Check-list of North American Birds, 1957).

Laysan Rail (Porzanula palmeri)

Current Status: Extinct.

The species was recorded from Lisianski in late March 1828. Herr C. Isenbeck, who visited that island and Laysan on the Russian vessel, Moller, reported to Kittlitz (op. cit.) "a kind of fowl, about as large as a ptarmigan; mixed grey and brown; running on the ground, singly, but at the same time rather numerous, on Moller [Laysan] and Lisiansky; very rapid and rather shy. Eggs were not found."

In March 1913 the scientific party of A. M. Bailey, G. Willett, W. S. Wallace, and D. F. Fullaway which had camped on Laysan since December 1912 captured about 100 Laysan Rails on that island for subsequent introduction to Lisianski Island and Midway Atoll (Bailey, 1956). Forty-five of these birds were released on Lisianski on 12 March 1913 (Log of the Revenue Cutter Thetis for 12 March 1913). Munter (op. cit.) saw several rails on Lisianski in March 1915. The birds were "bold and fearless; also very inquisitive and voracious." He saw one eating a tern's egg, ignoring the parent bird. The species was not noted on Lisianski by Wetmore (unpub. notes, 1923) in May 1923, and has never been seen by the POBSP. The colony introduced on Eastern Island, Midway Atoll became extinct in 1943 (Baldwin, 1947).

Golden Plover (Pluvialis dominica)

Current Status: Regular migrant.

Prior Records: Two shore birds were reported for the island by Isenbeck in March 1828 (Kittlitz, op. cit.). One, described as a "snipe," was observed in flocks on Lisianski, and is perhaps this species. A few plovers were observed by Palmer in June 1891 (Rothschild, op. cit.). Wetmore (unpub. notes, 1923) saw a flock of a dozen and a few solitary birds in May 1923.

About 50 birds were seen in March 1954 (Richardson, pers. comm.). Woodside and Kramer (op. cit.) saw a few birds in March 1961.

Population: The species is a seasonal migrant through the Leeward Hawaiians. On Kure Atoll, 300 miles to the northwest, greater numbers of birds move through in the fall than in the spring and some birds remain all summer.

About 400 birds were found on Lisianski in March 1963, and in March 1964 an estimated 600 birds were on the island when it was visited by the POBSP. Only 30 birds were noted in August 1964, and 50 were counted the following month. One small flock was seen on the southwest beach in August. In March 1965 a flock of about 950 plovers, with a few Ruddy Turnstones (Arenaria interpres) and Sanderlings (Crocethia alba), was observed and photographed (W. O. W. II) along the southern beaches. The flock maintained its identity and remained on the island for the three days that the POBSP team was there. Many individuals and small flocks were seen throughout the interior on this visit, and the island population was placed at 2000 birds. The species was not reported in July 1965.

Range: Breeds from the arctic coast of Siberia and Alaska, Banks, Parry, and North Devon islands south to central Siberia, southwestern Alaska, central MacKenzie, northeastern Manitoba, and southern Baffin Island. Winters from eastern India, southern China, and the Hawaiians south to Australia, Tasmania, New Zealand, and the Tuamotu Islands; also from Bolivia and southern Brazil south to central-eastern Argentina.

Movement: An adult banded by Eugene Kridler, Bureau of Sport Fisheries and Wildlife, on Lisianski on 11 March 1964 was recaptured by the POBSP on Kure Atoll on 1 September 1964. On 15 March 1965 this same bird was found dead by the POBSP on Southeast Island, Pearl and Hermes Reef. Pearl

and Hermes is 150 miles north-northwest of Lisianski, and Kure is 300 miles northwest of Lisianski.

Black-bellied Plover (Squaterola squaterola)

Current Status: Probably rare migrant.

A pair was collected on the rocky east beach in March 1965. They remained together each time they were flushed, until collected. They were first observed while they were feeding among the exposed rocky outcroppings in shallow water. On the same day a migrating flock of about 950 Golden Plovers was resting on the beach about a quarter mile away. It is possible that the Black-bellied Plovers had been led into the island in company with the Golden Plover flock. The POBSP has sight records from Midway Atoll and Kure Atoll.

Range: Breeds on the arctic tundras from north-central Russia across northern Siberia, southern Novaya Zemlya, the New Siberian Islands, and Wrangel Island, to the shores of the Gulf of Anadyr, northern Alaska, northwestern MacKenzie, and probably Banks, Victoria, Somerset, and Devon islands, south to southwestern Alaska, the Yukon River, north-central MacKenzie, King William Island, Melville Peninsula, Southampton Island, and southwestern Baffin Island. Non-breeding birds occur in summer in small numbers south to the British Isles, California, Panama, the Galápagos, Ecuáador, the Gulf coast, southern Florida, the Bahamas, and Jamaica. Winters in the Old World from the British Isles, the southern coast of Europe, the Cape Verde Islands, northwestern India, Burma, southern China, southern Japan, and the Solomons, south to southern Africa, Madagascar, Mauritius, the Seychelles, Ceylon, the Malay Peninsula, Australia, and New Zealand; in the New World locally along the Pacific coast from southwestern British Columbia, California,

and Mexico to Chile, including the Galápagos; from Louisiana south along the eastern shores of Central America, and on the Atlantic coast from New Jersey south through the West Indies to southern Brazil. Migrates in spring and fall along the coasts of the Old World, less commonly inland; in the New World in spring, along the Pacific coast, through the West Indies and along the Atlantic coast, and regularly but locally in the interior, west of Hudson Bay. In fall, over the spring route, and in America also east of Hudson Bay, spreading to Newfoundland. Casual in Labrador, Greenland, Iceland, the Faeroes, Azores, Madeiras, Clipperton Island, and interior Brazil. Accidental in the Hawaiian Islands and in Argentina. (AOU Checklist of North American Birds, 1957).

POBSP Specimens: USNM 494120, ♂, te. 2 mm., 13 March 1965; USNM 494121, ♀, ovary 10 mm., 13 March 1965.

Ruddy Turnstone (Arenaria interpres)

Current Status: Regular migrant.

Prior Records: "A species of sandpiper (perhaps Tringa minuta)" was seen "in flocks" on Lisianski by Isenbeck in March 1828 (Kittlitz, op. cit.). Rothschild (op. cit.) suggests that this was Calidris sp., but it seems more likely that it was Arenaria. "Some" were seen by Palmer in late June 1891 (ibid.). A dozen were seen by Munter (op. cit.) in March 1915. Wetmore (unpub. notes, 1923) saw a maximum of four birds in May 1923. Two to three hundred birds were seen on the island by Richardson (pers. comm.) in March 1954. A flock of 100 was observed by Woodside and Kramer (op. cit.) in March 1961.

Population: The species is a seasonal migrant through the Leeward Hawaiians. On Kure Atoll, 300 miles to the northwest, more birds move through in the fall migration, and some remain all summer.

The POBSP has seen the species on each visit to Lisianski. About 300 birds were present in March 1963, and about 1000 in March 1964. Only 200, mostly along the beaches, were noted for August 1964, but 1000 were estimated to be present the following month when flocks of 250 and 600 were observed. In March 1965 about 2000 birds were estimated to be on the island. Small flocks were found on the beaches, and many small flocks and individuals were seen throughout the vegetated interior. About 200 birds were present when the island was visited in July 1965.

Range: Breeds from northern Alaska, Victoria and Ellesmere islands, northern Greenland, Iceland, northern Scandinavia, Spitsbergen, Novaya Zemlya, and the New Siberian Islands south to the Yukon delta, King William Island, Boothia Peninsula, Southampton and Baffin islands, central Greenland, western Norway, and islands in the Baltic Sea; also the northern Siberian coast to the Bering Sea. Winters from central California, the Gulf coast, South Carolina, and the Bahamas south to central Chile and southern Brazil; also from the British Isles, the Mediterranean, south coast of western Asia, and the Hawaiians south to southern Africa and India, the East Indies, Australia and New Zealand. (AOU Check-list of North American Birds, 1957).

POBSP Specimens: USNM 494143, ♀, ovary 3 x 1.5 mm., 22 August 1964.

Bristle-thighed Curlew (Numenius tahitiensis)

Current Status: Regular migrant.

Prior Records: The species is not mentioned by Isenbeck, (Kittlitz, op. cit.), and a few birds were seen by Palmer in late June 1891 (Rothschild, 1893-1900).

One was seen along the shore by Munter (op. cit.) in March 1915. Wetmore (unpub. notes, 1923) saw a maximum of four in May 1923. About 35 birds were seen by Richardson (pers. comm.) in March 1954.

Woodside and Kramer (op. cit.) found them common in the grassy interior of the island in March 1961.

Population: The species migrates seasonally through the Leewards in small numbers. There is no apparent peak in seasonal movement, and some birds remain all summer, on Kure Atoll, 300 miles to the northwest.

From two dozen to 200 birds have been observed on each POBSP visit to Lisianski. Laysan and Lisianski are apparently more frequently used as resting points than any other islands in the chain, for greater numbers have been consistently found on these islands. The maximum count on Kure Atoll is nine individuals, and on Pearl and Hermes Reef 15 individuals. On Lisianski curlews are found throughout the grassy interior and in feeding flocks along the rocky eastern beach. An estimated 200 birds were present in March 1963, and 100 in March 1964. One hundred birds were again reported in August 1964, but only 24 were counted the following month. In March 1965 flocks of 30 to 40 were seen on the beaches, especially along the rocky eastern portion, and individuals were seen in the interior. About 150 were present on the island. In July of that year about 50 birds were found.

Range: Breeds in western Alaska near the mouth of the Yukon River. Recorded in summer at Kotzebue Sound, Hooper Bay, Kobuk River, Lopp Lagoon, and Mint River, Alaska. Winters from the Marshalls and Leeward Hawaiians south to the Santa Cruz, Fiji, Tonga, Samoa, Marquesas, and Tuamotu islands. Migrates directly over water to and from its summer and winter ranges. Casual west to the Marianas and Caroline Islands, and accidental in Japan. (AOU Check-list of North American Birds, 1957).

Other Specimen: USNM 301042, ♀, 19 May 1923.

POBSP Specimen: USNM 493202, ♂, 12 March 1963.

Wandering Tattler (Heteroscelus incanum)

Current Status: Regular migrant in small numbers.

Prior Records: The species was not noted by Isenbeck in March 1828, but a few were seen by Palmer in late June 1891 (Rothschild, 1893-1900). Wetmore (unpub. notes, 1923) saw a maximum of five in May 1923.

Population: From 10 to 24 individuals have been seen on four of the six POBSP visits to Lisianski. A few birds are found in every month of the year on Kure Atoll, 300 miles to the northwest, and there is no obvious seasonal peak in numbers.

Tattlers have only been seen on the beaches at Lisianski, and in March 1965 were seen chiefly along the rocky eastern beach. Twelve were seen in March 1963, ten each in March and August 1964, and 24 in March 1965.

Range: Breeds in the interior of Alaska from Mount McKinley south to Prince William Sound and east to Yukon and northwestern British Columbia. Apparently nests in the Anadyr range of northeastern Siberia. Non-breeding birds are found in summer in the Philippines, Guam, and Hawaii; also on the Pacific Coast of America south to Baja California, Cocos Island, and the Galápagos. Winters on the Pacific coast of America from southern California south to Revilla Gigedo, Galápagos and Ecuador; also from the Hawaiians, Mariana^s, and Philippines south to Fiji, Samoa, the Societies, and the Tuamotu Archipelago. Migrates chiefly over water with transients recorded from Amchitka and Nome, Alaska. Casual inland in North America, and from the Bonin and Volcano islands, Japan, Marcus, the Ryukyu Islands, and Formosa to New Guinea, Australia, and New Zealand. (AOU Check-list of North American Birds, 1957).

Other Specimens: USNM 301020, ♀, 19 May 1923; USNM 301021, ♀, 16 May 1923.

POBSP Specimen: USNM 493202, ♂, 12 March 1963.

Bar-tailed Godwit (Limosa lapponica)

Current Status: Accidental.

One was collected in March 1964. The POBSP has sight records from Laysan Island, 130 miles to the east, for March 1965.

Range: Breeds from northern Norway and Sweden, northern Finland, and northern Russia east through northern Siberia to western and northern Alaska. Winters from the British Isles, the North, Baltic, and Black seas, Arabia, and northwestern India south to Gambia and Italian Somaliland; also from southeastern China and the Philippines south to Australia, Tasmania, and New Zealand. (AOU Check-list of North American Birds, 1957).

POBSP Specimen: USNM 493478, ♀, ovary minute, 11 March 1964.

Sanderling (Crocethia alba)

Current Status: Regular migrant in small numbers.

Range: Breeds on Banks and Melville islands, northern Ellesmere Island, northern and northeastern Greenland, Spitsbergen, Taimyr Peninsula, New Siberian Islands, and North Land south to northern Mackenzie, southern Victoria Island, Melville Peninsula, the northwest coast of Hudson Bay, and western Southampton Island. Non-breeding birds occur in summer south to southern California, the Gulf coast, eastern Florida, northern Venezuela, the British Isles, Tunisia, and southern Somaliland. Winters from southern British Columbia, Massachusetts, and the Gulf coast south through the West Indies, Mexico and Central America to Southern Chile and Argentina; in the Old World from Ireland, the Outer Hebrides, the Mediterranean basin, Caspian Sea, Gulf of Oman, northern India, Burma, China and the Marianas, Marshall, and Hawaiian islands south to South Africa, Madagascar, Indian Ocean, Maldives, Java Borneo, Australia and the Phoenix and Union islands. Migrates in spring

and fall along the shores of the seas of the world, over water to Pacific islands, and inland particularly about larger bodies of water. Casual in Jan Mayen, Franz Josef Land, and New Zealand. (AOU Check-list of North American Birds, 1957).

Population: Individuals have been seen on four of the six POBSP visits to the island. About 20 birds were seen in March of both 1963 and 1964. Two were seen in September 1964, and five were seen with a flock of Golden Plover in March 1965.

Individuals are found from September through May, with a peak in September and October, on Kure Atoll, 300 miles to the northwest. The maximum count for 20 months data on Kure was 18, and counts over 10 occurred only in September and October.

Glaucous-winged Gull (Larus glaucescens)

Current Status: Accidental or rare visitor.

An immature was collected along the rocky east beach in March 1965. The POBSP has found this the most numerous species of gull in the Leeward Hawaiians. Six immatures have been collected by the POBSP on Kure Atoll, 300 miles to the northwest, and three immatures have been taken at Pearl and Hermes Reef, 150 miles to the northwest.

Range: Breeds from the Komandorskie Islands, St. Lawrence Island, western Alaska, the Pribilof and Aleutian Islands, and southeastern Alaska south to northwestern Washington. Non-breeding birds are found in summer south to California, Winters from Bering Island to Kamchatka, and the Kurile Islands south to Baja California, the Gulf of California, and Samoa.

Casual in eastern China and accidental in Oklahoma and the Hawaiian Islands (Laysan, Oahu, Hawaii). (AOU Check-list of North American Birds, 1957).

POBSP Specimen: USNM 494133, ♂, te. 4 mm., 12 March 1965.

Herring Gull (Larus argentatus vegae)

Current Status: Accidental.

One was seen at sea near the island, and presumably the same bird was collected on the east beach in February 1963.

Range: Breeds in Siberia from the eastern side of the Taimyr Peninsula to the Gulf of Anadyr. Winters south to Kamchatka, the Kuriles, Japan, the Ryukyus, central China, Formosa, and the Bonin Islands. Found casually in western Alaska, the Aleutians, and British Columbia.

POBSP Specimen: USNM 493353, ♀?, 14 February 1963.

Sooty Tern (Sterna fuscata)

Current Status: Breeds annually in large numbers.

Prior Records: The species was not found by Isenbeck on Lisianski in March 1828 (Kittlitz, op. cit.). In late June 1891 Palmer found it the most abundant species on the island (Rothschild, op. cit.). Many small nestlings were present. One colony of about 1000 birds was forming at the island in March 1915 (Munter, op. cit.), but they had not begun to nest. Wetmore (unpub. notes, 1923) found a colony of about 250 pairs, mostly with eggs, nesting in the grass tract at the northern end of the island. About 2000 birds were present in March 1954 (Richardson, pers. comm.). In March 1961 Woodside and Kramer (op. cit.) noted large numbers circling over the central part of the island, but nesting had not yet begun.

Population: The species has been found on each POBSP visit to the island. No population estimate was made on the first visit in March 1963, but large numbers were circling over the island at night. In March 1964 an estimated 75,000 birds were circling over the island, but only a tenth of them were sitting on the ground. In August of that year an estimated 160,000 adults

and 40,000 nestlings were found distributed in eight large colonies. Most of the birds were in bunchgrass habitat, though large numbers were found in the morning-glory areas at the north end of the island. By September 1964 only 4000 immatures remained on the island. About 3500 birds were circling the island in two groups in March 1965. A small group of about 500 was circling a bunchgrass area at the northern end of the island. The remainder was forming over the interior of the southern end of the island, and sitting briefly during the day. The following July an estimated 250,000 adults, 50,000 immatures, and 50,000 nestlings were found on the island. The colony was largely confined to bunchgrass habitat in the interior of the island.

Reproduction: Palmer found many small nestlings on Lisianski in late June 1891 (Rothschild, op. cit.). Wetmore (unpub. notes, 1923) found about 250 pairs with eggs in May 1923. Large numbers were circling the island in March 1961, but no eggs were found (Woodside and Kramer, op. cit.).

The POBSP has found adults forming over the island on each of its March visits. Most of the 50,000 nestlings found in July 1965 were nearly fledged. An equal number of immatures were found. A few pairs were still incubating eggs. In August 1964 the 40,000 nestlings ranged from one third grown to nearly fledged. Some immatures were present. There seemed to be an adult with each nestling or immature at night. A complete albino and a partial albino nestling was observed. By September 1964 only 4000 immatures remained in the colony.

On Kure Atoll, 300 miles to the northwest, egg-laying occurs primarily in May, and hatching in June. Adults leave the atoll before the immatures, and most of the latter are gone by mid-September. The POBSP has observed too much variation in the cycles of individual breeding colonies of this

species to permit the generalization that the cycle on Lisianski is the same as on Kure. However, the limited data available for Lisianski suggest that the cycle there is, indeed, similar to that on Kure.

Movement: An adult banded on Sand Island, Johnston Atoll, about 650 miles to the southeast, in September 1963, was recovered on Lisianski in August 1964, and several orange-tagged birds from the former atoll have been observed, but not captured, on Lisianski.

Other Specimens: USNM 191503, no sex or date; USNM 191504, no sex or date; USNM 191505, no sex or date; USNM 191506, no sex or date; USNM 300584, ♂, 19 May 1923; USNM 300585, ♀, 19 May 1923; USNM 300586, ♀, 16 May 1923.

POBSP Specimen: USNM 495461, ♀, ovary 8 x 5 mm. largest ovum 2 mm., 16 July 1965.

Gray-backed Tern (Sterna lunata)

Current Status: Breeds annually.

Prior Records: The species was first recorded for Lisianski by Henry Palmer (Rothschild, op. cit.), who found a few in late June 1891. About 500 birds were found in company with Sooty Terns in March 1915 (Munter, op. cit.). One bird was found on an egg at the edge of a frigate colony. In May 1923 about 250 pairs had eggs and nestlings in the bunchgrass tract at the northern end of the island (Wetmore, unpub. notes, 1923). Richardson (pers. comm.) found about 300 there in March 1954. Woodside and Kramer (op. cit.) found a few on eggs in March 1961.

No mention made in Palmer's diary -

Population: The species has been common on four of the six POBSP visits to the island. About 200 adults were found in March 1963, and 500 were estimated to be present in March 1964. In August 1964 only three adults and two immatures were seen, and the species was not noted the following month. On

a careful check of the entire interior in March 1965 one nestling was found and an estimated 2500 adults and 1100 eggs were noted. The discrepancy between these data and that for March 1963 and 1964 is probably due to incomplete censusing of the heavily vegetated areas on the two previous visits. An estimated 300 adults and 100 immatures were found at the perimeters of the Sooty Tern colonies in July 1965.

Reproduction: Munter (op. cit.) found one bird on an egg in March 1915. Eggs and nestlings were found by Wetmore (unpub. notes, 1923) in May 1923, and a few eggs were found by Woodside and Kramer (op. cit.) in March 1961.

Eggs were not found by the POBSP in March of 1963 and 1964, but the party did not have sufficient time ashore to survey the entire interior. In March 1965 the species was nesting throughout much of the bunchgrass area of the interior. Some birds were also nesting under Scaevola along the east beach. Only one small nestling was found, but over 1000 eggs were found in the process of banding the nesting colony. Only a few immatures and adults were found in August 1964, and the species was not noted the following month. Adults and immatures were found at the periphery of the Sooty Tern colonies in July 1965.

A very small nesting colony utilizes Kure Atoll, 300 miles to the northwest. Eggs have been found here in April, June and July. Nestlings have been found in July, and immatures in July and August. There is some indication in the POBSP data on tern breeding in the Leewards that the season is a week or two later on each more distal island in the chain. Thus the cycle on Lisianski would be expected to be a few weeks earlier than on Kure. This theory is supported by the breeding data available from POBSP visits to Pearl and Hermes Reef, 150 miles northwest of Lisianski,

where eggs have been found from March through June, and nestlings and immatures from April through September.

Other Specimens: USNM 191501, no date or sex; USNM 191502, no date or sex; USNM 300627, ♂, 18 May 1923.

POBSP Specimen: USNM 494124, ♀, ovary 17 mm., largest ovum 2 mm., 147.3 grams, 13 March 1965.

Noddy Tern (Anous stolidus)

Current Status: Breeds annually, probably resident.

Prior Records: About 300 non-breeding birds were found on the island in March 1915 by Lt. Munter (op. cit.). Wetmore (unpub. notes, 1923) estimated about 500 pairs to be present, and found a few eggs, in May 1923. The nesting colonies were scattered along the eastern shore and around the depression in the south-central portion of the island. Nests were often found in the little depressions at the mouths of shearwater burrows, and some had small bones and feathers added to the rim. Flocks also rested along the beach at the tide mark. Ten to 20 birds were seen in March 1954 by Richardson (pers. comm.).

Population: Individuals have been found on each POBSP visit. About 200 adults were present in March 1963, but were not nesting. Only 25 birds were noted in March 1964, but in August of that year there were about 1600 adults and 400 immatures. The following month about 2700 birds, including immatures, were present. Approximately 500 adults, with some eggs and nestlings, were found in March 1965. In July of that year the survey reported 1000 adults and 300 nestlings.

Reproduction: Wetmore (unpub. notes, 1923) found a few eggs in ground nests in May 1923. No eggs or nestlings were found in March 1963 or 1964, but both were found in small numbers in March 1965. Nests have been found

on the ground, and also in shrubbery and in the few trees. About 400 immatures were present in August 1964. The survey reported 300 nestlings in July 1965. Nests were found in the Scaevola and on the ground. Eggs and immatures were also found, but their number was not estimated.

On Kure Atoll, 300 miles to the northwest, egg-laying occurs primarily in May and June, and hatching in June and July. Most nestlings fledge by late August. The cycle on Lisianski appears to be earlier than on Kure.

Movement: A local banded on Whale Island, French Frigate Shoals, in June 1963 was recaptured as an adult on Lisianski in August 1964. The islands are about 500 miles apart.

Other Specimens: USNM 300518, ♂, 17 May 1923; USNM 300519, ♂, 17 May 1923; USNM 300658, ♂, 13 April 1923.

POBSP Specimens: USNM 495541, ♀, ovary 11 x 7 mm., largest ovum 2.5 mm., 17 July 1965.

Hawaiian Noddy Tern (Anous minutus)

Current Status: Breeds annually, probably resident.

Prior Records: Henry Palmer found a few birds on Lisianski in late June 1891 (Rothschild, 1893-1900). Two nesting colonies, comprising perhaps 1000 birds, were found near the shacks on Lisianski in March 1915 (Munter, op. cit.).

Fairly well made nests were placed in small shrubs or plants or on platforms built up from the ground. Eggs and nestlings were found. Wetmore (unpub. notes, 1923) found about 1000 adults on the beaches in May 1923, but no nests. Sixty to 80 birds were present in March 1954 (Richardson, pers. comm.).

Roosting birds were found in the ironwoods in March 1961 (Woodside and Kramer, op. cit.).

Population: The species has been found on each POBSP visit to the island. About 300 adults were found in March 1963. Some birds were sitting on nests, but no eggs were found. In March 1964 there were an estimated 1000 adults present, and about 200 nests with equal numbers of egg and nestlings. About 400 birds were present in August 1964, but only 100 the following month. There were 2500 adults on the island in March 1965. Most of the 400 nests found still had eggs. In July 1965 the population was estimated at 1000 adults and 300 nestlings.

Reproduction: Munter (op. cit.) found the species nesting, with eggs and young birds, in the shrubs and plants around the shacks, or on the ground, in March 1915.

Nesting and roosting birds have been found primarily in the ironwoods and tall Scaevola along the western side of the island. In March 1964 there were about 200 nests in this area, with equal numbers of eggs and small nestlings. In March of the following year an estimated 400 nests had about 350 nestlings and 50 eggs. The July 1965 survey found about 300 nestlings in nests in this area. Nestlings ranged from half-grown to nearly fledged. Surveys in August and September 1964 did not report breeding activity or young birds.

Movement: A Hawaiian Noddy Tern banded as a nestling on Lisianski in March 1964 was recaptured on Sand Island, Johnston Atoll, 550 miles to the south-east, in February 1965. Five orange-tagged birds from Sand-Johnston were observed on Lisianski on 14 July 1965, but none could be captured.

Other Specimens: USNM 300454, ♂, 17 May 1923; USNM 300455, ♂, 19 May 1923.

Fairy Tern (Gygis alba)

Current Status: Breeds annually in small numbers, probably resident.

Prior Records: Henry Palmer found the species numerous on Lisianski in late June 1891 (Rothschild, op. cit.). Pairs were found sitting on the ground and the single egg was found placed on Scaevola branches. Wetmore (unpub. notes, 1923) saw only two birds in May 1923. About 25 were found by Richardson (pers. comm.) in March 1954. Woodside and Kramer (op. cit.) found birds roosting in the ironwoods in March 1961. *not as cited*

Population: A small population is probably resident on Lisianski. The species has been observed on each POBSP visit to the island. An estimated 50 birds were present in March 1963 and 1964. Twelve nests were found on the latter visit. No nests were found in August 1964, when the population was again placed at 50 birds. Nine adults were counted the following month, and the total population was placed at 25. There were about 100 birds on the island in March 1965 when 15 nests were found. The following July about 50 adults were noted and 15 nestlings were found.

Reproduction: Eggs have been found on Lisianski in March, and nestlings in March and July. Seven eggs and five nestlings were found in March 1964, and 15 eggs in March 1965. Fifteen nestlings were found in July 1965.

Other Specimens: USNM 191500, no sex or date.

Insert into paragraph for reptiles
Green Sea Turtle (Chelonia midas)

Current Status: Common visitor, perhaps resident.

Prior Records: Captain Urey Lisiansky (op. cit.) found numerous turtles on the island in October 1805. Several very large turtles were found on the beach by Herr C. Isenbeck in late March 1828 (Kittlitz, op. cit.). Captain John Paty (op. cit.) of the Hawaiian schooner Manuokawai found turtles on

the island in May 1857, as did Captain N. C. Brooks (op. cit.) who visited Lisianski in May 1859. John Cameron (op. cit.) visited the island twice in the 1880's and 1890's, killing both turtles and seals for meat. Wetmore (1925) found a great many turtles on Lisianski in May 1923. He counted 80 in one 300 yard stretch of beach. Animals ranged in carapace length from four feet to 15 inches. He noted numerous animals feeding in submarine fields of algae around the island, and felt that their only enemies were sharks. In March 1961 Woodside and Kramer (op. cit.) counted eleven turtles, including some fairly small ones, on the beach, but saw no signs of eggs or laying. Kramer (1963) tagged five turtles on Lisianski, and saw several dozen offshore. Several small ones, weighing less than 15 pounds, were observed.

Population: Turtles have been observed on each POBSP visit to Lisianski.

About 30 were found in March 1963. Thirteen large and one small turtles were counted in March 1964. A few were noted in August 1964, and five dead hatchlings were found the following month. Five were counted in March 1965 and 13 in July of the same year.

Reproduction: Woodside and Kramer (op. cit.) found no signs of eggs or laying in March 1961. Small turtles have been seen on several POBSP visits, and five dead hatchlings were found in September 1964.

Amerson, A.B., Jr. 1968.

comments on U. Pacific Exped

Brennan, 196

Bibliography for Lisianski Island

Air Weather Service (MATS) Climatic Center, USAF.

Anon. 1845. The Boston Bee for 2 April 1845.Anon. 1845. Boston Daily Journal for 11 July 1845.Anon. 1846. The Friend, Honolulu, for 15 August 1846.Anon. 1847. The Salem Observer for 16 January 1847.Anon. 1910. Paradise of the Pacific for 3 February 1910.

Anon. 1951

Bailey, A. M. 1952a. The Hawaiian monk seal. Mus. Pic. 7: 1-30.

Bailey, A. M. 1952b. Laysan and Black-footed albatrosses. Mus. Pic. 6: 2-78.

Bailey A. M. 1956 Brds of Laysan etc

Bequaert, J. C. 1941. The Hippoboscidae of Oceania (Diptera). Occ. Papers Bishop Mus. 16 (11): 247-292.

~~Brooks, N. C. 1859. Cruise of the Gambia, Capt. N. C.
Brooks. The Pacific Commercial Advertiser, 11 August 1859.~~

Brooks, N. C. 1860. Islands and reefs west-northwest of the Sandwich Islands, Pacific. Naut. Mag. 29: 499-504.

✓ Bryan, E. H., Jr. 1926. Insects of the Tanager Expedition. Bishop Mus. Spec. Pub. 11: 31

✓ Bryan, E. H., Jr. 1938. Lisianski, an island of Hawaii. Parad. Pac. ~~50~~ 50 (2): 31, 33-34.

✓ Bryan, E. H., Jr. 1942. American Polynesia and the Hawaiian Chain. Honolulu, 1942.

Bryan, W. A. 1915. Natural history of Hawaii. Honolulu, 1915. ?

✓ Buck, P. H. 1953. Explorers of the Pacific. Bishop Mus. Spec. Pub. 43.

Cameron, J. [Farrell, A. ed.]. 1928. John Cameron's Odyssey. New York, 1928.

✓ Christophersen, E., Caum, E. L. 1931. Vascular plants of the Leeward Islands, Hawaii. Bishop Mus. Bull. 81: 1-41.

Clark, A. H. 1949. Ophiuroidea of the Hawaiian Islands. Bull. 195 Bishop Mus.

✓ Clapp & Woodward, 1968

✓ Cresswell, M. 1939. Open boat voyages. The Marine Observer Vol. 16, No. 134.

- cite in text

incorrect cite?

Fain, and Amerson, A.B., Jr. 1968.

Harvey, 1953

Hornell, J. ed. 1934. Log of the Schooner "Ada" on a fishing cruise in
the North Pacific, 1882. Mariners' Mirror 20: 426-37

- ✓ Elschner, C. 1915. The Leeward Islands of the Hawaiian group. Honolulu, 1915. (reprinted from the Honolulu Advertiser, 1915).
- ✓ Edmondson, C. H., Fisher, W. K., Clark, H. L., Treadwell, A. L., and Cushman, J. A. 1925. Marine zoology of tropical central Pacific. Tanager Expedition Publ. No. 1. Bishop Mus. Bull. 27.
- ✓ Fowler, H. W. 1927. Fishes of the tropical central Pacific. Bishop Mus. Bull. 38.
- Fowler, H. W. 1928. The fishes of Oceania. Bishop Mus. Mem. Vol. 10.
- Fowler, H. W. 1931. The fishes of Oceania. Supplement 1, Vol. 11 (5): 313-381.
- Fowler, H. W. 1934. The fishes of Oceania. Supplement 2, Vol. 11 (6): 385-466.
- Fowler, H. W. 1949. The fishes of Oceania. Supplement 3, Vol. 12 (2): 37-186.
- ✓ Fowler, H. W., Ball, S. C. 1925. Fishes of Hawaii, Johnston Island, and Wake Island. Bishop Mus. Bull. 26.
- Hamlet, O. C. 1904. Letter to \times the Secretary of the Treasury of the United States of America, dated 23 June 1904. - cite in text
Harry, 1953.
- ✓ Kenyon, K. W., Rice, D. W. 1959. Life history of the Hawaiian Monk Seal. Pac. Sci. 13: 215-252.
- ✓ Kenyon, K. W., Rice, D. W., Robbins, C. S., Aldrich, J. W. 1958.
- Kittlitz, F. H., von. 1834.
- King, J. 1956 (*Osprey record in Elepua*)
- ✓ Kramer, R. J. 1963.
- ✓ Kramer, R. J., Woodside, D. H. 1961. Hawaiian Island National Wildlife Refuge Photo Station Experiment. (undated, unpublished manuscript - work done March 1961).
- ✓ Lisiansky, Urey. 1814. A voyage round the world, in the years 1803, 4, 5, and 6; performed by order of his imperial majesty Alexander the First, Emperor of Russia, in the ship Neva. London, 1814.

Sibley, F.C. and McFarlane, R

1968

Suikla, 1959

Tsuda, R. 1966

Maa, T.C. 1968.

- ✓ Munro, G. C. 1942. Birds of Hawaii . . . an ocean cruise. Elepaio 2: 34-36, 41-43, 49-51, 1941; 3: 2-3, 5-6, 7-8, 12-13, 15-16, 18-19, 1942; 22-23, 26-27, 1943.
Munro, G.C. 1944.
- ✓ Munter, W. H. 1915. Annual report of the Coast Guard for 1915, p. 134-136.

NAVSTA Midway Forecast Handbook.

Pell, J. 1844. The Polynesian for 12 October 1844.

- (✓) Rice, D. W., Kenyon, K. W. 1962. Breeding cycles and behavior of Laysan and Black-footed albatrosses. Auk 79 (4): 517-567.

*Rice + Kenyon, 1962
other etc*

Rice, D.W. 1960. (seal count data)

- ✓ Richardson, F. 1957. The breeding cycles of Hawaiian sea birds. Bishop Mus. Bull. 218: 1-41.
- ✓ Roach, F. L. 1961. East Pacific Survey Phase I. (undated, unpublished manuscript).

- ✓ Rothschild, W. 1893-1900. The avifauna of Laysan and the neighbouring islands. London, 1893-1900.

→ Schlemmer, M. 1904. Letter to G. R. Carter, Governor of the Territory of Hawaii, dated 17 December 1904.

- cite in text]

→ Stearns, H. T. 1946. Geology of the Hawaiian Islands. Terr. Hawaii, Div. Hydrography Bull. 8: 1-106.

← use more recent etc

→ Thompson, G. B. 1948. Mallophaga collected by the Tanager Expedition. Occ. Papers Bishop Mus. 19 (9): 195-200.

1938?

→ Timberlake, P. H. 1924. Records of the introduced and immigrant chalcid flies of the Hawaiian Islands (Hymenoptera). Proc. Hawaiian Ent. Soc. 5 (3): 418-449.

→ United States Coast and Geodetic Survey Chart No. 4186.

United States Hydrographic Office Chart No. 4, rev. August 1924.

United States Navy, Log of the U. S. S. Iroquois for 1904, from the Archives of the United States of America.

United States Revenue Cutter Service, Log of the R. C. Thetis for 1904, 09, 10, 11, 12, 13, 14, 15, 16 from the Archives of the United States of America.

- ✓ Walker, F. D. 1909.

Walker, R.L. 1964.

- ✓ Warner, R. E. 1963. Recent history and ecology of the Laysan duck. *Condor* 65 (1): 2-23.
- ✓ Wetmore, A. 1923. Personal field notes from the Tanager Expedition. (unpublished manuscript).
- ✓ Wetmore, A. 1925. Bird life among lava rock and coral sand. *Nat. Geogr. Mag.* 48: 77-108.
- Wheeler, W. M. 1934. Revised list of Hawaiian ants. *Occ. Papers Bishop Mus.* 10 (21): 1-21.
- ✓ Woodside, D. H., Kramer, R. J. 1961. Report on a survey trip to the Hawaiian Islands National Wildlife Refuge, March, 1961. (unpublished manuscript).
- Zimmerman, E. C. 1948. *Insects of Hawaii*. Honolulu, 1948.